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Readers are invited to send in their comments and discussion of articles published in *Soviet Geography*. Readers are also encouraged to submit suggestions as to published Soviet geographic literature worthy of translation. Such suggestions should relate to articles of general substantive or methodological interest rather than materials of narrow, specialized appeal.

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Notice to Readers: Reprints of the issues Nos. 1-2, 3, 4, 5 and 6 of SOVIET GEOGRAPHY 1960, temporarily out of print, are now available.

TRANSLITERATION TABLE

Russian			English	Russian			English
А	а	*а*	a	Р	р	*р*	r
Б	б	*б*	b	С	с	*с*	s
В	в	*в*	v	Т	т	*т*	t
Г	г	*г*	g	У	у	*у*	u
Д	д	*д*	d	Ф	ф	*ф*	f
Е	е	*е*	e*	Х	х	*х*	kh
Ж	ж	*ж*	zh	Ц	ц	*ц*	ts
З	з	*з*	z	Ч	ч	*ч*	ch
И	и	*и*	i	Ш	ш	*ш*	sh
Й	й	*й*	y	Щ	щ	*щ*	shch
К	к	*к*	k	Ъ	ъ	*ъ*	"
Л	л	*л*	l	Ы	ы	*ы*	y
М	м	*м*	m	Ь	ь	*ь*	'
Н	н	*н*	n	Э	э	*э*	e
О	о	*о*	o	Ю	ю	*ю*	yu
П	п	*п*	p	Я	я	*я*	ya

(*) Instead of e, use ye at the beginning of names, after vowels and after the soft sign (').

The transliteration table is supplied for the general information of readers and to enable them to identify the geographic names on maps that will be reproduced from time to time in SOVIET GEOGRAPHY.

The transliteration system is the one proposed by the United States Board on Geographic Names. For more general use in textbooks and other popular needs, the following simplifications are recommended by the editor of SOVIET GEOGRAPHY:

1. Eliminate the use of (') and (").
2. Use i for iy, and y for yy.
3. Convert diphthongs ay, ey, oy, uy to ai, ei, oi, ui.

THE THIRD CONGRESS OF THE GEOGRAPHICAL SOCIETY OF THE USSR

THE HEAT AND MOISTURE REGIME AND GEOGRAPHIC ZONALITY

By A. Z. Grigor'yev

(Abstract: This paper by a leading Soviet theoretical physical geographer traces the historical development of the Soviet doctrine of geographic zonality and the role played by heat-moisture relationships in determining the structure, the dynamics and the development of natural geographic zones. The paper includes a table of geographic zonality and explains the periodic character of geographic zonality. Am American review article that provides useful background is: Jacek I. Romanowski, A Survey of Heat and Water Balance Research in the Soviet Union, University of Washington, Discussion Paper No. 41.)

More than sixty years have passed since V. V. Dokuchayev, one of the outstanding naturalists of his time, advanced in the 1890's the idea of the existence of close cause-and-effect relationships between the components of the geographic environment and pointed out the interdependence of these components and the consequent integrity of the geographic environment. At the end of the 1890's he established the fact that one of the most important characteristics of the structure of the geographic environment was its zonality -- horizontal in the plains and vertical in the mountains -- and that it was based on areal differences in climatic conditions. Examining in 1900 the climatic factors of geographic zonality, V. V. Dokuchayev concentrated his attention on the heat and moisture regime and, along with it, on the relationship between the amount of annual precipitation and the magnitude of evaporation of moisture from the earth's surface. Dokuchayev thus came close to the important idea that geographic zonality was based not only the distribution of heat and moisture, but on differences in heat-moisture relationships since evaporation depended mainly on the thermal conditions in the warm part of the year. However, he did not concretely formulate that proposition.

In the same year, 1900, illness prevented the great researcher from continuing his work.

Thereafter, the study of geographic zonality was directed along other paths, reflecting the general empirical trend in the development of the physical geography of that time.

The main attention of researchers during the first three decades of the 20th century was centered on clarification of important specific questions. They included: a more detailed differentiation of geographic zones (for example, L. S. Berg, 1913), determination of the natural characteristics of individual zones (G. N. Vysotskiy, 1905; especially A. N. Krasnov, 1910; G. I. Tanfil'yev, 1911; B. A. Keller, 1923; and others), the methodology of intra-zonal and general physical-geographic regionalization (S. S. Neustruyev, 1910 and 1918; R. L. Abolin, 1914; B. A Keller, 1923; and others).

Using empirical methods, geographers continued to seek factors of geographic zonality among climatic indices, such as, the ratio of precipitation to evaporability, the ratio of annual precipitation to annual temperature, and so forth. However, a more or less satisfactory coincidence of the isolines of such indices with the boundaries of the geographic zones was observed only partly, so that this search did not yield positive results. Many years of research were required before the proposition that the relationship between heat and moisture was the fundamental factor of geographic zonality could be definitely formulated and finally received recognition.

The first stage in this process corresponds to the late 1910's and the 1920's (S. S. Neustruyev, B. B. Polynov, I. M. Krasheninnikov), but chiefly to the 1930's when, in the search of ways of reforming physical geography along consistently materialistic lines, a number of new propositions were advanced regarding the object, tasks and scientific methodology of physical geography (A. A. Grigor'yev, 1931, 1932, 1936, 1937, 1938, 1938a, 1939) and in the doctrine of landscapes (M. A. Pervukhin, 1932; A. D. Gozhev, 1932; D. V. Nalivkin, 1932; etc.).

These studies advanced the point of view that the object of physical geography was the geographic envelope of the globe, consisting of a number of closely interrelated and interdependent geospheres forming a separate integral phenomenon of nature subject to special study. For the successful study of the geographic envelope it was necessary to investigate its interdependent natural processes, especially those forming the basis of its integrity and changing with geographic zones, oblasts and landscapes, as well as the comparative degree of intensity of those processes (by zones, oblasts, etc.).

It was necessary, in other words, to investigate the complex geographic cause-and-effect relationships and laws characteristic of the geographic envelope. It should be borne in mind that with respect to energy and other aspects the geographic envelope is divided into two tiers, the surface tier and the deep-seated tier.

The processes of the surface tier and zonal changes in the structure of the geographic envelope are based on solar radiation. Radiation is the basis of the heat energy of the great majority of natural processes of the geographic envelope in its close interaction with the dynamics of the atmosphere, which plays a leading role in the distribution of precipitation over the earth's surface. The geographic belts and zones that make up the geographic envelope are in close mutual relationship and interaction, and must therefore be investigated in that relationship i.e., as a part of a single whole.

The heat energy base of the deep-seated tier of the geographic envelope is the internal heat of the earth.

For thorough study of the structure and dynamics of the geographic envelope and its geographic zones, it is necessary to apply not only qualitative

but also quantitative methods, among which the balance method is especially productive. It allows one to determine clearly and thoroughly the quantitative and qualitative properties and differences in the structure of the geographic envelope by zones, and the relationships between the different phenomena. Such a study of the zones and of the geographic envelope as a whole, based on an investigation of the balances of their constituent substances and inherent kinds of energy, is important both with respect to theory and for the discovery of methods for the most productive utilization and alteration of the natural conditions for economic purposes. These balance investigations require field-station observations in different geographic zones, and the building of laboratory models of natural processes.

At the same time, the geographic envelope as a natural phenomenon with a long and complex history of development should also be studied from the standpoint of its development.

These new ideas were opposed to the purely empirical principles that dominated physical geography at the time.

These principles rested largely upon the erroneous methodological views of A. Hettner and his followers, who regarded geography as a "spatial" (chorologic) science studying the phenomena of the earth's surface solely with respect to space. This one-sided trend could not but seriously impede the formulation of a theory of physical geography and consequently of a theory of geographic zonality.

The above-mentioned new ideas in geography were advanced as a foundation for formulating a new theory of physical geography in keeping with the level of development of modern natural science.

These ideas were to serve also as the basis for formulating a theory of geographic zonality as one of the fundamental geographic laws. For this purpose, as well as to verify these new scientific principles, the author undertook to compile a series of characterizations of individual geographic belts under the general title "An experiment in the characterization of the basic types of the physical-geographic environment" (1938, 1938a, 1939, 1942, 1946).

The basic aim of this work was a comparative study of the structure, dynamics and development of the geographic zones and subzones making up each geographic belt; an investigation of the characteristics of the interrelationships and interdependences, and of the interchange of matter and energy between the components of the geographic envelope; a determination on that basis of the magnitudes and qualitative differences among the annual productivities of the bio-mass of the plant cover and animal life of the various zones, as indices of the level of bio-energy produced by the biotic components of the geographic envelope; determination of the levels of development of other natural processes, connected in one way or another with the factors of productivity of the biotic components of the zones; all this was done with

the broadest possible utilization of the balance method. The aims of the study also included the determination of the characteristics of interaction and interchange between the zones making up the geographic belts and the determination, on the basis of all these data, of the basic laws of the structure, dynamics and development of the geographic environment.

The execution of these tasks was limited by the level of development of the geographic and cognate sciences.

The writing of essays devoted to individual geographic belts demonstrated that the application of the new scientific methods made it possible to study the structure and development of the geographic envelope and its constituent belts and zones with greater depth than before, and to establish new geographic laws.

Many of the progressive ideas were adopted by Soviet scholars, for example, S. V. Kalesnik, who developed them in his Osnovy obshchego zemlevedeniya (Principles of General Earth Science) (1947) and in his other works.

A number of difficulties continued to be encountered, especially in the application of the balance method, related to the fact that this method had not been adequately worked out, for example, with respect to the biocomponents, for which the scheme of a balance equation still had to be established; and also related to the inadequacy of observation data and of data on the distribution over the earth's surface of the quantitative indices of the members of the radiation and water-balance equations due to the absence of methods for determining a number of their components.

It was therefore often necessary to confine oneself to simple characterizations of the balances of the components of the geographic environment, such as "positive," "negative" or "neutral" (close to zero), which was, of course, quite inadequate.

Beginning in the middle 1940's, meteorologists, hydrologists and oceanologists started to accumulate data on the radiation and heat balance of the earth's surface. At the same time, water-balance research was expanded, including the construction of maps of a number of components of the water balance of the land.

This research was carried out for the causal interpretation of the laws of the moisture and heat regime and for calculations and forecasts of the indices of that regime.

The development of the hydrometeorological sciences in that direction has testified to the special significance of the balance method in the study of basic geographic processes.

Progress made in this research also opened up broader prospects for the

development of the ideas proposed by us in the study of the general problems of physical geography.

Further development of the theory of geographic zonality led us (1946a) to the conclusion that zonality was based on changes not only in the annual radiation balance and in the amount of annual precipitation, but also in the relationships between them.

These relationships characterize the degree of participation of water in the geographic environment of a given zone. And upon the degree of this participation, combined with the quantity of heat, depends the character of the structure and development of the geographic environment of the zones. Thus we have finally succeeded in establishing and formulating in its most general form the basic law of interrelationships between geographic zonality and the changes in the heat and moisture regime, a law which, as we have seen, V. V. Dokychayev came so close to in 1900 but which he was unable to formulate in the state of knowledge at that time.

By utilizing the intensity (level) of natural processes for the characterization of zones, we have shown that the "most easily perceptible" external feature of this intensity is the magnitude of output of living organic matter. As a result of qualitative analysis of the effect of different factors on the intensity of output of living matter, we have come to the conclusion that the intensity is confined to the heat energy inherent in the geographic environment and varies within these limits according to the extent to which atmospheric precipitation approaches the optimum, at which point the output of organic matter is at its maximum and the amount of precipitation somewhat exceeds the magnitude of evaporation from the earth's surface (including transpiration) corresponding to local thermal conditions.

The output of living organic matter drops both when the participation of water in the structure and development of the geographic zones diminishes and when it increases from the optimum level.

These findings have made it possible to use the heat and water balance equations in determining the specific quantitative relationships between the output of living organic matter (and thus the character of the plant cover) of the geographic zones, on the one hand, and the meteorological factors, on the other.

This question attracted the attention of M. I. Budyko, who at that time was working on closely related problems. He made a careful and in many ways novel study of the natural processes whose indices are members of the heat and water balance equations (1947, 1948, 1948a, 1949, 1950, 1951), and established new laws in the process.

Budyko devoted special attention to methods of calculating the heat and water balances of the land surface (1950a), since it developed in the course of his research that the productivity of the plant cover and the level of other

natural processes are in close cause-and-effect relationship with the heat and water balances of the underlying surface, and not with the heat balance of the "earth's surface — atmosphere" system, as had been assumed.

Another important step in the study of the meteorological factors of geographic zonality was M. I. Budyko's following hypothesis (1948): in the formula representing the ratio between the annual radiation balance and annual precipitation the latter should be represented in heat units - in calories of the latent heat of evaporation, as the author demonstrated mathematically (by the equation of relationship). The moisture-supply index thus obtained was later called "radiation index of dryness." Furthermore, Budyko showed (1949, 1950) that the isolines of this index coincided well with the boundaries of the most important geographic zones in the plains of the temperate and tropical latitudes and that a complete analogy was observed in both areas between the changes in the dryness index and the succession of zonal vegetation types.

This contributed to a wider acceptance and further elaboration of the problem under discussion (A. A. Grigor'yev, 1951; A. G. Isachenko, 1953 and 1953a; and other scholars) and to progress in the study of the basic meteorological factors of geographic zonality, especially in the field of research of the water-and-heat regime of the earth's surface (M. I. Budyko, 1954, 1955, 1956).

In 1955 the Main Geophysical Observatory named for A. I. Voyeykov published, under the editorship of M. I. Budyko, the Atlas teplovogo balansa (Heat-Balance Atlas), containing mean annual and mean monthly world maps of total radiation, radiation balance, loss of heat to evaporation, turbulent heat exchange and evaporation, and a mean annual map of the heat received or lost by the surface of the ocean through the action of marine currents. A world map of the radiation index of dryness was also published (M. I. Budyko, 1955).

The present state of the study of the problem under discussion is also characterized by substantial progress in the investigation of the cause-and-effect relationships between the heat and moisture regime and geographic zonality.

These interrelationships, as follows from our investigations (1954, 1956, 1957) and all that has been said above, are based on the magnitude of the radiation balance, the magnitude of the precipitation and the ratios between radiant heat and precipitation expressed in the form known as radiation index of dryness.

The study of the changes in the indices of the radiation index of dryness by geographic zones has shown that, in zones of highest productivity of the bio-mass both in the temperate and in the tropical latitudes, this index is 0.8-1, i.e., the ratios between the radiant heat and the precipitation (for the year) approach unity. Such a heat-moisture ratio results in a

combination of a certain heat regime and moisture regime in which predominate periods of unimpeded and uninterrupted development of the processes of transpiration and evaporation (from the earth's surface) and of aeration of the soil and subsoil. Such moisture-supply conditions are optimal for the life activity of the plant cover. They are also optimal for the development of aerobic soil and siliceous bacteria. The intensity of development of the latter causes the intense development, in these zones, of "chemical weathering" and the formation of a thicker crust of weathering than in other zones of near-by latitudes.

The latest research by physiologists has shown that these optimal conditions of soil and subsoil moisture are especially favorable both for photosynthesis and for the outflow of its products from the assimilating organs. This fact is also very significant, since the accumulation of photosynthesis products in the assimilating organs greatly reduces the intensity of photosynthesis. All this contributes to the high productivity of the plant cover of the geographic zones in which the radiation index of dryness is near unity.

However, this productivity also depends to a large degree upon the magnitude of the annual radiation balance: in zones of optimal moisture supply in the tropical latitudes productivity is much higher than in the temperate belt.

As we pass from the above described zones to those in which moisture conditions depart increasingly from the optimal and the radiation index of dryness deviates more and more from unity (in either direction), the conditions for photosynthesis deteriorate correspondingly; at the same time, the production of living matter diminishes.

A comparative study of the structure, dynamics and development of the geographic zones of the temperate and tropical latitudes has shown that the zonal composition, structure, dynamics and development change as we pass from zones of optimal moisture to zones of insufficient or excessive moisture.

These changes are expressed in the unequal participation in the structure of the geographic envelope of those components whose presence is not so essential and constant as the presence of the lithosphere and atmosphere, which enter everywhere into the composition of the geographic envelope.

Such "inconstant" components are: water in liquid form, the plant and soil covers and animal life, which may enter into the composition of the geographic envelope in different amounts at various places, but are almost entirely lacking in certain zones and regions. This property of the geographic envelope we call the "degree of completeness" of the structure of that envelope.

The quantity of matter of each of these "inconstant" components of the geographic envelope of a given zone is usually closely connected with the qualitative characteristics of the given component. For example, the quantity of living vegetable matter of each given zone is usually inseparably

Table 1. TABLE OF GEOGRAPHIC ZONALITY

Heat-energy base (Radiation balance)

Moisture-supply (radiation index of dryness)	less than 0 (high latitudes)	0-50 Cal/cm^2/year (south Arctic, sub-Arctic and middle latitudes)	50-75 Cal/cm^2/year (subtropical latitudes)	more than 75 Cal/cm^2/year (tropical latitudes)
less than 0 (extremely excessive)	I Perpetual snow			
0-1 (excessive)				
0-0.2		IIa Arctic desert		
0.2-0.4		IIb Tundra (tree patches in south)	VIa Subtropical hemihylaea with swamps	Xa Equatorial forest swamps
0.4-0.6		IIc Northern and middle tayga	VIb Subtropical rain forest	Xb Very swampy equatorial forest
0.6-0.8		IId Southern tayga and mixed forests	same	Xc Moderately swampy equatorial forest

(optimal) 0.8-1	IIe Deciduous forest and forest steppe	same	Xd Equatorial forest, passing into lighter tropical forest and wooded savannas
1-2 (moderately inadequate)	III Steppe	VIIa Hard-leaved subtropical forests and shrub	XI Dry savanna
		VIIb Subtropical steppe	
2-3 (inadequate)	IV Semi-deserts of the temperate belt	VIII Subtropical semi-desert	XII Desert savanna (tropical semi-desert)
more than 3 (extremely inadequate)	V Deserts of the temperate belt	IX Subtropical desert	XIII Tropical desert

Note: It should be borne in mind that in accordance with the method of determining the radiation indices of moisture supply, the values of the radiation balance used in constructing the table relate to conditions of a moistened underlying surface. In the case of arid regions these values differ substantially from the magnitudes of the radiation balance relating to the actual condition of the underlying surface. They are considerably smaller.

connected in quality with the ecological zonal characteristics; the less water in liquid form there is in a given zone, the more mineralized it is, as a rule; and so forth.

The quantity of matter and the inseparably connected quality of the zonal biocomponents and the hydro-component, together with the differences in the radiation regime of the underlying surface, directly or indirectly affect certain properties of the atmosphere and of the upper layers of the lithosphere, lending them definite zonal or regional characteristics.

Also connected with the degree of completeness of the structure of the geographic envelope, as well as with the history of its development in the geologic past, is the degree of variety in the composition of its "inconstant" components.

Likewise closely related to the completeness of the structure and to the variety of the composition of the geographic envelope is the degree of multiformity of its natural processes (the degree of multiformity of its dynamics).

Summing up the laws of geographic zonality discovered by us, we came (1954, 1956, 1957) to the following conclusions:

In addition to the magnitude of the annual radiation balance of the earth's surface and the amount of annual precipitation, the ratio of these two values, as expressed by the radiation index of dryness, plays an important role in the structure, the dynamics and the development of the surface tier of the geographic envelope. In those zones and regions where the heat-moisture ratio is close to unity, the structure and the dynamics of the surface tier of the geographic envelope are distinguished by the greatest multiformity, and its composition is distinguished by the greatest diversity compared with other zones of near-by latitudes. As the ratio of the annual radiation balance to precipitation departs from one, either because of a growing excess or because of a growing shortage of precipitation, the multiformity of structure and the diversity of composition of the surface tier and its natural processes decrease. Several important changes in the structure, the dynamics and the composition of the geographic envelope produced by a growing disproportion between the amount of heat and moisture are common to both arid and excessively moist zones, but manifest themselves differently in many respects in both cases.

It follows that in various zones with similar magnitudes of the annual radiation balance of the earth's surface the multiformity of structure and dynamics and the diversity of composition of the surface tier of the geographic envelope increase as the ratio between that balance and annual precipitation approaches unity, due account being taken of the effect of development of the area in the geologic past.

On the other hand, given similar ratios between the annual radiation balance and annual precipitation (except for certain cases of extreme disparity), the

multiformity of structure and dynamics and the diversity of composition of the geographical envelope (under similar orographic conditions) increase with the annual radiation balance of the underlying surface, again due account being taken of the effect of development of the area in the geologic past.

A comparative study of the location of the boundaries of both the excessively moist and the arid zones and subzones of temperate and tropical latitudes has shown that the boundaries, which mark deep qualitative changes in the geographic envelope, are located where the disparity between heat and moisture is two to three times greater than on the corresponding boundaries of the nearest zone where the heat-moisture ratio approaches unity.

All these interrelationships between the moisture-and-heat regime and geographic zonality were discovered as a result of comparative study of the zones of tropical, temperate and, in part, high latitudes. The extension of the comparative analysis to the zones of the subtropics, made jointly by the author and M. I. Budyko in 1956, made possible further progress in the study of these interrelationships: it resulted in the compilation of a table of geographic zonality covering all the geographic belts (Table 1, pp.10-11), which made it possible to establish the periodic character of geographic zonality ("the periodic law of geographic zonality"). The essence of that law is that within each latitudinal belt there is a definite agreement between the boundaries of the natural zones and the isolines of certain values of the radiation index of dryness and that in various latitudinal belts natural zones similar in several essential features correspond to identical values of the radiation index of dryness. This means that as we pass from one latitudinal belt to another (which corresponds to a change in the value of the radiation balance, i.e., the heat-energy basis of natural processes) we find in several natural zones (corresponding to changes in moisture-supply conditions) a periodic recurrence of similar features together with the differences caused by changes in heat-energy conditions.

The discovery of these important laws, together with the laws established previously, opens before us broad prospects for an even deeper understanding of the interrelations between the heat-and-moisture regime of the earth's surface and geographic zonality.

It is clear from the foregoing that the study of these interrelations is of great interest both from a theoretical and a practical point of view, especially in agriculture.

The investigation of some of these interrelations, for example the role of the heat exchange and the moisture exchange in the structure, dynamics and development of geographic zones (A. A. Grigor'yev, 1958) was started only recently; definitive results have not yet been published and cannot yet be characterized. Other subjects still await investigation.

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THE STUDY OF THE HEAT AND MOISTURE BALANCE OF THE UKRAINE AS A BASIS FOR MEASURES TO RAISE THE PRODUCTIVITY OF AGRICULTURE

By V. P. Popov, T. K. Bogatyr', G. P. Dubinskiy, A. S. Skorodumov

(Abstract: The paper discusses the availability of data for calculating the heat balance and the moisture balance for the territory of the Ukraine. The problem of determining total evaporation, evaporation from the surface of the soil and transpiration of agricultural crops is treated in detail. The authors discuss practical applications of heat and moisture balance work, including the setting of irrigation norms, the study of the regimes of stream reservoirs, swamp drainage and the study of the effect of tree plantings on the microclimate of sheltered fields.)

(The first page of introductory remarks is blank in the available mimeographed Russian-language copy of this paper and has not been translated -- Editor, S.G.)

The present state of science makes it possible to treat as one of the most important tasks of geography the study of the heat and moisture balance in the Ukraine for the purpose of grounding major measures designed to raise the productivity of agriculture.

The possibility of employing the heat balance for various purposes results from the fact that considerable progress has been made in the Soviet period in studying solar radiation and other elements of the radiation balance. Of special significance are the studies by M. I. Budyko, T. G. Berlyand, D. L. Layktman and others on the radiation and heat balance.

In its most general expression, the heat balance may be represented by the equation: $R = Lv + M + B$,

where R is the radiation balance, Lv the loss of heat through evaporation, M the expenditure of heat in warming the atmosphere (turbulent heat exchange), and B the expenditure of heat in warming the soil. For long-term mean annual magnitudes, the expenditure of heat on heat exchange with the deep layers of the soil (B) is eliminated from the equation, leaving:

$$R = Lv + M.$$

This equation is widely used by M. I. Budyko in estimates of the main components of the heat balance, the loss of heat through evaporation, and through turbulent exchange.

Consequently, for the heat balance we need, first of all, data on the radiation balance and its constituent elements. For the Ukrainian SSR the magnitudes of the radiation balance are available only in the form of estimates on the maps published in the studies of M. I. Budyko and T. G. Berlyand. They differ considerably. For example, on T. G. Berlyand's map (1949) the long-term mean magnitude of the annual radiation balance for Kiev is about 40 Cal/sq. cm., while on M. I. Budyko's map (1956) it is about 30 Cal/sq.cm., and the isoline of 40 Cal/sq.cm. runs along the coasts of the Black Sea and the Sea of Azov, 400 to 500 km. farther south. This is apparently explained by the fact that actual data were available only for Odessa, where systematic observations have been made on radiation-balance elements. It should be stated incidentally that these data were not entirely reliable because the Odessa meteorological observatory lies on the seacoast. In view of the great differences in the radiation balance between sea and land, it is obvious that these data cannot be regarded as representative. Hence, the estimated data obtained are also very approximate.

In the Ukrainian SSR, 16 actinometric stations more or less evenly distributed over the territory have been organized in the post-war period for observations of direct and diffused radiation, total radiation, albedo, and the radiation balance. From 14 stations there are data ranging over five to nine years. These data can, of course, be used to improve the radiation-balance estimates for the Ukrainian SSR. One of the next tasks should be to estimate the mean annual radiation balance of the Ukrainian SSR on the basis of the available data.

Calculation of the loss of heat through total evaporation from a territory is simple if there are reliable data on the atmospheric precipitation and stream runoff. By using the dense network of precipitation gauges, the snow-survey traverses made by many meteorological stations, as well as the dense network of hydrologic stations and posts at which stream flow is recorded, reliable data can be obtained on the total evaporation from a territory by the equation:

$$V = r - s,$$

where V is the total evaporation, r the precipitation, and s the runoff in mm., all in terms of long-term mean values. This method of computing the annual total evaporation from a given territory is widely used by many investigators. Unfortunately, its application is very limited. One cannot, for example, obtain by this method data on evaporation over a small territory during individual months or seasons, during individual years, and so forth.

A. A. Skvortsov in Tashkent (1947) has worked out a gradient method of determining the total evaporation from a given section. Experimentation with that method in the south of the Ukraine has yielded positive results (P. I. Kolesnik, 1958). However, both A. A. Skvortsov's method and other gradient methods have limited application because of the great complexity of the required observations, and do not always lead to positive results. The gradient methods of determining total evaporation are not used in the meteorological stations of the Ukrainian SSR except for nine actinometric stations, where gradient observations are made to estimate other elements of the heat balance.

To determine total evaporation, V. P. Popov employed one-meter-high soil evaporators, in which plants were grown. Although experimental investigations have yielded good results (V. P. Popov, 1928), this method has only limited application because of its unwieldiness and because the data obtained will not always be entirely reliable in view of the individual characteristics of growth of the various plants. With some minor changes, this device is employed as evaporator GGI-500/100 to calculate the total evaporation from fields in grain crops. Such observations are made at nine stations in the Ukrainian SSR.

The soil-moisture balance method can be most widely employed for calculating total evaporation; at the same time, the moisture balance by itself can also be employed for solving many important theoretical and practical problems. In its most general expression, the moisture balance in the soil can be represented by the following equation:

$$w_1 - w_2 = (v + s + o) - (r + k + P),$$

where w_1 is the moisture reserve in a given layer of soil (usually in a layer a meter thick) at the beginning of the period, w_2 the same at the end of the period, r the atmospheric precipitation, k the condensation of moisture in the layer, P the moisture brought up from deeper layers, v the total evaporation (from soil+plants), s the surface runoff, o the percolation of moisture into deeper soil layers. The solution of this equation for a determination of total evaporation requires data for the six other elements, only two of which, soil moisture and the precipitation, are subject to systematic observations in the network of hydrometeorological stations of the Ukrainian SSR; for the four other elements individual investigations, but no systematic observations, are made in the network. However, these investigations make it possible to simplify the equation for the warm part of the year, when determination of the moisture balance in the soil is especially important, for areas that are more or less level (with only gentle slopes), with the ground-water-level at more than five meters, on soils that are more or less capable of holding moisture (not sands). The main field areas in the steppe and forest-steppe zones of the Ukrainian SSR fulfill these conditions. Under these conditions, runoff, condensation and percolation of moisture into the deeper soil layers during the warm part of the year are in nearly all cases negligible compared with the other elements -- precipitation and total evaporation (V. P. Popov, 1948). Hence the equation can be simplified without great error into the form: $w_1 - w_2 = v - r$.

For the calculation of the total evaporation by this simplified equation, the necessary data are available at a comparatively large network of stations and posts of the Ukrainian SSR. Thus, measurement of the precipitation by means of Tret'yakov's precipitation gauge and by the rain gauge is effected at 213 stations and 818 posts. Self-recording precipitation gauges have been installed at 70 stations and 19 posts. In addition, self-recorders have been installed at 49 posts at the Transcarpathian runoff station and at 72 posts at the Veliko-Anadol runoff station.

Systematic determinations of soil moisture (every ten days in the warm part of the year) are made for a number of crops at 147 stations and 13 posts of the UGMS (Ukrainian State Meteorological Station) of the Ukrainian SSR to a depth of 100 cm. (to a depth of 150 cm. at 14 stations). The numbers of stations and posts by groups of crops are as follows:

Crops	Number of stations and posts	Crops	Number of stations and posts
Winter	159	Other industrial crops	25
Early spring	75	Potatoes	47
Corn	101	Grasses, etc.	39
Sunflowers	13	Fruit crops and windbreaks	12
Sugar beets	59	Grapes	14

For the precursors of winter wheat, soil moisture is determined as follows:

clear fallow	74 stations
occupied fallow	13 "
stubble	94 "

For a number of stations there are long-term data. Furthermore, soil moisture is determined by scientific-research institutes and experimental stations, especially in connection with reclamation and irrigation. These data have been used in a number of publications.

The radioactive method of determining soil moisture devised by A. I. Danilin is now being tested at seven stations of the Hydrometeorological Service of the Ukrainian SSR. The first tests have yielded positive results. After the final test, the new method will apparently be widely employed, since it greatly simplifies the technique of determining soil moisture compared with the drilling method. It makes it possible to determine quickly the soil moisture at the required depth and at the same time it can be employed for direct determination of the moisture reserve in the required soil layer. In using this method, control measurements of the soil moisture by the drilling method are necessary.

Thus, there are good prospects for using the simplified equation in determining total evaporation on the fields of the Ukrainian SSR.

However, it should be noted that total evaporation data are best employed in studying the individual components of the heat balance. For other purposes, especially for solving many questions of agricultural production, it is far from sufficient to know merely the total evaporation. It is more important to know how much is lost through evaporation from the surface of the soil and how much through transpiration from agricultural plants. This follows especially from the fact that the whole system of farming in arid regions is based on the accumulation, conservation and economical use of soil moisture. On the basis of the available data it can be stated with confidence that the greater part of the moisture in arid regions is expended in evaporation from the surface of the soil and the lesser part in the transpiration of agricultural plants, even in fields with a high level of agricultural technique. When the level of farming technique is low, the unproductive loss of moisture through evaporation from the surface of the soil increases sharply at the expense of the loss through transpiration. In agricultural techniques for arid regions, much attention is paid to the question of controlling the unproductive loss of moisture through evaporation from the surface of the soil. That is the reason for the shallow plowing of stubble after the harvesting of grain crops, the early spring harrowing (to seal in the moisture), the loosening of the ground between the rows of crops requiring cultivation, etc. Tests have also been made of measures that almost entirely eliminate evaporation from the surface of the soil, as, for example, mulching, i.e., covering the ground with tar paper or with transparent film.

It is also important to note that evaporation from the surface of the soil depends mainly upon precipitation; the influence of other meteorological elements is insignificant in the generalization of data for ten-day periods and months. On the other hand, transpiration of plants is determined mainly by the same factors as evaporability, i.e., the effect of solar radiation, temperature, air humidity, turbulence, as well as by the biological characteristics of plants; in other words, the laws of the processes of evaporation from the surface of the soil and of the transpiration of plants are quite different. All this constitutes evidence that a knowledge of total evaporation is insufficient in agriculture, and that separate account must be taken of the evaporation from the surface of the soil and the loss of moisture in the transpiration of plants. If we take separate account of these elements, the equation will assume the form:

$$w_1 - w_2 = (v_1 + T) - r,$$

where v_1 is evaporation from the surface of the soil, T the transpiration of plants. By this equation it is possible to determine the loss of moisture through transpiration of plants, if the other elements, including the loss through evaporation from the surface of the soil, are known. This element is determined by means of Popov's No. 1 soil evaporators, GGI-500/50 evaporators and small evaporators installed among the crops. Popov's No. 1 evaporators are recharged with fresh soil monoliths every 5 to 10 days, the GGI-500/50 evaporators every 15 days, and the small evaporators

every day. Because of their daily recharge, the small evaporators yield the most reliable data. They can be employed under the most varied conditions, including irrigated fields but, unfortunately, the daily recharge requires a relatively large expenditure of labor.

In the Ukrainian SSR observations of evaporation from the surface of the soil have been made with the Popov evaporator in the pre-war and post-war periods. Since 1952, observations have been conducted with GGI-500/50 evaporators at eleven hydrometeorological stations. Because of growing demand, the methods of recording evaporation from the surface of the soil must be revised, and the network of stations considerably expanded.

For some purposes it is advisable to determine the coefficient of the effectiveness of precipitation, which gives an idea as to what part of the precipitation goes to replenish the moisture reserves in the soil and can be utilized by agricultural plants. In the Ukraine, for example, coefficients of 0.6 have been obtained for the cold part of the year, and 0.3 for the warm part. The coefficient shows that large supplies of moisture are built up by spring from winter precipitation, with about 60 per cent of the water retained by the soil for use by agricultural plants, while only about 30 per cent of the summer precipitation can be utilized by the crops, the remaining 70 per cent being lost through evaporation from the surface of the soil. Consequently, the effectiveness of winter precipitation is twice as great as that of summer precipitation.

Because of the complexity of obtaining data on the transpiration of farm crops under field conditions, indicrect methods of estimating transpiration are often employed. For this, it is advisable to use data on evaporability, i.e., data on the maximum possible evaporation from a moistened surface. These conditions are met by soil evaporators without plants with daily wetting (V. P. Popov, 1932), soil evaporators with plants and constant wetting (S. V. Thornthwaite, 1939); they are met to a lesser extent by water evaporators (GGI-3000) and evaporators with a moistened surface in the form of filter paper (Pisha, A. A. Solopko). The advantage of soil evaporators with and without plants over water evaporators was noted at the congress of the Agrometeorological Commission of the World Meteorological Organization held in Warsaw in October, 1958.

In the Ukrainian SSR, Popov No. 1 soil evaporators with daily wetting were used for recording evaporability in the pre-war period. In the post-war period observations have been conducted at 26 points of the hydrometeorological network exclusively with the water evaporator GGI-3000. The question of the methods of recording evaporability must be re-examined. In addition to their indirect use, reliable experimental data on evaporability will make it possible to refine the empirical evaporability formulas for the indirect estimates of plant transpiration that are widely employed without having an adequate scientific basis.

To summarize the foregoing, we should note first of all that there has

been definite progress in the study of the elements making up the heat and water balance in the Ukrainian SSR in the post-war period. This applies especially to the study of solar radiation and the elements of the radiation balance, precipitation, soil humidity, total evaporation, and to a lesser extent to evaporation from the surface of the soil and evaporability.

In spite of the imperfectness of our knowledge about the heat and water balance, we can contribute, with an approximation corresponding to the state of that knowledge, to the solution of certain important production problems.

The heat and moisture balance, together with the balance of mineral and organic substances, constitute a group of important geographic processes. As a result of the interaction of the three basic factors of landscape formation, these processes are instrumental in bringing about the present-day development of the following components of the geographic environment:

(1) the relief, through weathering, surface and deep-seated erosion, transfer and deposition of mineral and organic matter, remodeling of relief forms;
(2) the climate, as a long-term regime of weather and its constituent elements (air and soil temperature, humidity of the air and soil, precipitation, wind, cloudiness, etc.);
(3) the long-term regime of rivers, swamps, lakes, seas and the hydrologic regime of the land and sea;
(4) the soil cover, through accumulation and destruction of humus, mineral salts, change in the mechanical, physical and chemical properties of the mother rock;
(5) the plant cover and animal life, as characteristic biocoenoses.

The individual components of the environment in turn do not develop in isolation, but in dependence upon and interaction with the other components, and under the ever-increasing action of man.

The interaction of physical-geographic factors and components of the geographic environment forms the basis of the methods of physical-geographic regionalization (V. P. Popov, A. M. Marinich, A. I. Lan'ko, O. V. Poryvkina, 1958) and of the agroclimatic regionalization of the Ukrainian SSR (V. P. Popov, 1958).

In the agroclimatic regionalization of the Ukrainian SSR there is an important discrepancy between the generally accepted boundary between the forest zone and forest-steppe zone west of Zhitomir and the moisture balance. According to the moisture balance, this boundary should run southwestward from Zhitomir and east of Khmel'nitskiy and Kamenets-Podol'sk, i.e., considerably farther south than the generally accepted boundary. An examination of the soil map and the map of natural vegetation cover (reconstructed) shows that north of the moisture-balance boundary there is a predominance of gray forest soils and podsolized chernozems, which in the past were occupied

by broadleaf forests with a large beech, oak and hornbeam content. An exception is part of the Volhynian-Podolian Upland between Ternopol' and Khmel'nitskiy, where thick low-humus chernozems are characteristic. The explanation apparently lies in the fact that in this area the forests were destroyed many centuries ago and that under the influence of systematic tilling the dark-gray forest soils have acquired the properties of deep low-humus chernozems (soil degradation). The question can be definitively solved by using pollen analysis to reconstruct the vegetation of this area of deep low-humus chernozems for the period preceding tillage.

In the south of the Ukraine and in the Northern Crimea, more than 150,000 hectares were being irrigated in 1957. The Ingulets and Krasnoznamensk irrigation systems, largest in the Ukrainian SSR, have now been put into operation.

Study of the heat and water balance of the irrigated territory of the Ukrainian SSR for the purpose of establishing irrigation norms and changing the hydrometeorological regime of the fields has now been going on for some time. The microclimate group of Khar'kov University under the direction of G. P. Dubinskiy has been working for nine years in the irrigated fields of the Kamensk and Brilevskaya experimental reclamation stations, as well as in the Askaniya-Nova Nature Preserve. This research has yielded data on the radiation and heat balance, as well as on the microclimate of irrigated and non-irrigated fields of corn, cotton, spring and summer potatoes, annual and perennial grasses, tomatoes, beets and cabbage, and in vineyards. Telescopic masts have been employed for gradient observations. These investigations have established a considerable increase in the radiation balance in irrigated fields due mainly to a decrease in reflected radiation (albedo); the loss of heat through evaporation in the heat balance is sharply increased (up to 90 per cent of all energy losses), while the turbulent heat exchange drops to 5-10 per cent (a four-to fivefold reduction). The temperature in the surface layer of the air is reduced by 10° to 15° (by 20° to 30° on the ground), transferring the plants, as it were, into another climatic zone.

Similar investigations on a smaller scale have been conducted by Kiev University (I. K. Polovko) and the Odessa Hydrometeorological Institute (E. A. Burman, G. I. Perelet). The data obtained give evidence of the considerable hydrometeorological effect of irrigation in the south of the Ukraine and in the Northern Crimea.

On the basis of data on the moisture balance during the spring and summer periods, a good case has been made for soaking of the soil before the winter season as one of the most important measures in the irrigated regions of the south of the Ukrainian SSR (V. P. Popov, 1951).

Unfortunately, little work has yet been done in studying the soil-moisture balance and its constituent elements in irrigated fields. Only at experimental reclamation stations and certain hydrometeorological stations in irrigated

fields are observations being made of the humidity of the soil, soil evaporation and evaporability. It is necessary to expand these observations considerably. Attempts to calculate the total evaporation in irrigated fields from gradient observations, the heat balance and the evaporability at a given time have no practical significance. Hence, along with the study of the radiation and heat balance, it is necessary to engage on the broadest scale in a study of the soil-moisture balance and its basic constituent elements in irrigated fields.

Hydrometeorological observatories have been organized at the Kakhovka and Lenin (Zaporozh'ye) reservoirs on the Dnieper River to make observations according to a full-fledged program aimed at the study of the regime of reservoirs. The observations cover the water temperature and chemistry at various depths, gradient observations of temperature, air humidity and wind (at heights of 0.2 and 2.0 m.) above the water surface, evaporation from the water surface, of the swell on wave gauges (instrumentally recorded), of the reshaping of shorelines, glaciothermal observations with ice surveys, aerial ice reconnaissance, etc. Organization of an observatory at the Kremenchug Reservoir has commenced. The number of observation posts at present is:

Kakhovka Reservoir	17
Reservoir named for Lenin	11
Kremenchug Reservoir	3

Nine additional posts are to be organized at the Kremenchug Reservoir.

Considerable attention is to be paid by geographers in the current seven-year period to the problem of swamp drainage. In the Ukrainian Poles'ye, especially in the western Rovno and Volyn' oblasts, where swamps cover more than 20 per cent of the whole area, a great amount of swamp drainage is being done to develop land under intensive agriculture. Measures are being taken to straighten and deepen river channels, to canalize swampy areas, to erect dams, reservoirs and hydroelectric stations. All these measures are aimed mainly at combating the consequences of the swampiness of the Poles'ye, but not its causes.

The main cause of the swampiness lies in the fact that a huge amount of water runs off into the streams, lakes and swamps from the precipitation in the Poles'ye itself and in the neighboring regions of the forest-steppe (especially in the Volhynian-Podolian Upland). On the average, the yearly runoff (according to V. A. Troitskiy, 1948), in the Ukrainian Poles'ye reaches 100 to 150 mm., of which at least two-thirds is underground runoff formed as a result of filtration of the water through the layers of soil and subsoil, particularly in sandy areas. In view of the fact that more than 70 per cent of western and central Poles'ye and as much as 60 per cent of eastern Poles'ye are sandy, streams, lakes and swamps are fed mainly by filtration through sands. A radical improvement of the physical soil properties and a raising of the fertility of the sandy soils, by introducing a large amount of organic (peat) and mineral fertilizers and lime, combined with a

high general level of agricultural technique, would insure a sharp rise in crop yields and at the same time would considerably increase on-the-spot consumption of water. The planting of aftermath crops (for hay and green manure) would further increase this consumption of water. As a result, the ground-water feeding of streams, lakes and swamps would be considerably reduced, that is, the main cause of swampiness would be substantially limited. At the same time, similar measures must be planned in the neighboring forest-steppe regions belonging to the Poles'ye drainage basin. In the forest-steppe regions, with their fertile and moisture-holding soils (on loess), it is considerably easier to bring about a sharp decrease of filtration. Here, too, in addition to a generally high level of farm technique, there should be plantings of aftermath crops on a wide scale (V. P. Popov, 1955).

It is know that peat soils are associated with a special type of microclimate, differing from the microclimate of mineral soils, and that the moisture balance and heat balance have a distinctive character. These questions have been little studied, in the case of the Ukrainian Poles'ye. Little study has been made of the physical properties of the Poles'ye soils, especially those of the western part.

Research on the water regime of soils and subsoils under tree plantings in the steppe began at the end of the 19th century at Veliko-Anadol under the direction of G. N. Vysotskiy. Since the 1930's, after organization of the Ukrainian Scientific Research Institute of Forestry and Reclamation, that research has been conducted according to a broad program at several points of the steppe and forest-steppe zones. Of special importance is the work done at the Vladimir experimental station (Kherson Oblast), which has the most effective narrow windbreaks of the gapped type. The soil-water regime in the windbreaks and in the sheltered fields was studied in the pre-war years by B. I. Logginov and V. I. Lebedikov, and in the post-war years by D. P. Ryzhikov and A. S. Skorodumov (to a depth of 4.5 meters).

This research shows that narrow windbreaks of the gapped type increase soil moisture in the sheltered fields, especially in wet years, thus raising the yields of all crops. Soil moisture in sheltered fields is used more economically and more productively. There is a deeper soaking of soil and subsoil, which results in the leaching of harmful water-soluble salts. The deep desiccated layer of the southern chernozem is either entirely lacking or very thin in sheltered fields, while it is observed annually in the case of non-sheltered fields, except winter fallow.

In dry years the bulkier crops on sheltered fields use up more water than the lower-yield crops on non-sheltered fields; this tends to even out the soil-moisture level in both types of fields by the end of the growing season since all available reserves of productive moisture are usually used up in both cases.

The highest soil moisture in the spring is observed at a distance

corresponding to five to ten times the tree height of the windbreaks of the gapped type, in contrast to the windbreaks of the closely planted type, which accumulate snow drifts along the margins at the expense of the sheltered fields. The ground-water level in sheltered fields often lies closer to the surface, and in wet years the ground-water level is observed to rise in the spring (A. S. Skorodumov, 1959).

A further objective is to study all the elements of the moisture balance in windbreak-sheltered fields, especially evaporation and evaporability.

Microclimatic observations have been carried out according to a broad program at the Vladimir experimental station in windbreaks, in sheltered fields and in the open steppe both before World War II (by Yu. P. Byallovich) and especially after the war (by Ya. A. Smal'ko). These observations cover winds, temperature and air humidity up to a height of 15 meters, and the temperature of the soil to a depth of 20 cm. A. A. Skvortsov's method is used to observe the pulsation of the air temperature. The results of these observations have been published in the Trudy (Transactions) of the Ukrainian Scientific Research Institute for Forestry and Reclamation and other publications (Ya. A. Smal'ko, 1954). They shed light on the effect of windbreaks of both the gapped and the closely-planted types and of allee plantings on the microclimate.

In conclusion it should be noted that while a certain progress has been made in the post-war period in the study of the heat and moisture balance of the Ukrainian SSR, the results are still inadequate for providing a basis for the measures aimed at an increase in farm productivity envisaged by the 21st party congress. Research must be further expanded to improve the methods of studying the heat and moisture balance, especially study of the loss of water through evaporation from the surface of the soil and through the transpiration of crops, as well as the study of evaporability. The network of actinometric points and of points for determining elements of the water balance should be considerably expanded. Attention should be given to the study of the heat and water balance as applied to irrigation in the south of the Ukraine and the Northern Crimea, as well as to the regime of reservoirs, swamp draining in the Ukrainian Poles'ye, and field windbreaks in the steppe and forest-steppe. In this work, not only the observatories and stations of the Administration of the Hydrometeorological Service of the Ukrainian SSR and the institutes of the Ukrainian Academy of Agricultural Sciences, but also the geography faculties of the universities and other higher educational institutions and scientific-research institutes should take an active part.

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REPORT OF ACTIVITIES OF THE NATIONAL COMMITTEE OF SOVIET GEOGRAPHERS

By M. B. Gornung, Secretary

(From Izvestiya Akademii Nauk SSSR, seriya geograficheskaya, 1961, No. 2, p. 108)

The activities of the National Committee of Soviet Geographers in 1960 were connected mainly with the 19th International Geographical Congress and the 10th General Assembly of the International Geographical Union, convened in Stockholm in the summer of 1960. In the course of the year there were five expanded meetings of the National Committee and several meetings of the Bureau (executive council) of the committee. These meetings discussed Soviet preparations for scholarly and organizational participation at the Congress, the results of the Congress and the General Assembly, and the current business of the committee relating to international contacts of Soviet geographers. Many Soviet geographers who are taking an active part in international scholarly life were invited by the National Committee to participate in these meetings. At the beginning of 1960, at the Third Congress of the Geographical Society of the USSR in Kiev, the National Committee had an opportunity to acquaint the Soviet geographic community at large with the character of the work and the forms of activities of the National Committee. That report was published in the Izvestiya Akademii Nauk SSSR, seriya geograficheskaya (see Soviet Geography, May 1960, pp. 76-84), as was a report of activities of the National Committee as of the beginning of 1960 (see Soviet Geography, April 1961, pp. 33-40).

The basic work of the Committee in 1960, as in preceding years, was reflected in the results of the participation of Soviet geographers in the General Assembly and in the Congress. These results have been reported in detail (see Soviet Geography, April 1961, pp. 40-46).

The results of the Congress have been discussed in the Geographical Society of the USSR at Leningrad, in its Moscow branch, at a general meeting of the Ukrainian Geographical Society, in the Institute of Geography of the Academy of Sciences USSR, in the geography faculties of the universities of Moscow, Leningrad, Kiev and others, and at other geographical institutions that were represented at the Congress.

On December 9, 1960, the results of the Congress and the Assembly were presented to a meeting of the Presidium of the Academy of Sciences USSR, which discussed in detail the report of the National Committee of Soviet Geographers. The Presidium approved the activities of the Soviet delegation at the Congress and the Assembly, as well as the preparations under the guidance of the National Committee. A resolution of the Presidium noted that although the Soviet delegation had been numerically smaller than those of some other countries, such as the United States(with more than 200

geographers) and West Germany, the Soviet geographers had taken a leading part in the scholarly program, having contributed about 20 per cent of the sectional papers. In terms of their scholarly level and breadth of topics, the Soviet papers stood out among most of the foreign contributions. The Soviet delegation achieved important successes in organizational questions in the work of the General Assembly and, in particular, assured the broad participation of Soviet geographers in the administrative and scholarly bodies of the IGU.

In accordance with a decision of the Presidium of the Academy of Sciences USSR, the Academy's Publishing House will publish in 1961 a volume titled XIX Mezhdunarodnyy Geograficheskiy Kongress (19th International Geographical Congress) (35 to 40 printers' sheets), prepared by the National Committee. The volume will consist of three sections: (1) reference materials on the Congress and the Assembly and the speeches of Soviet delegates in the Assembly; (2) the papers of Soviet geographers that were read in Stockholm; (3) reviews of the work of the Congress sections and the meetings of the IGU commissions, reviews of the publications prepared especially for the Congress in the Scandinavian countries, the Congress organizers, and in the USSR, and reviews of the excursions in which Soviet geographers participated.

Besides these principal activities the National Committee continued in 1960, as usual, to maintain and expand contacts with the national committees and geographic institutions of several foreign countries.

THE INTERNATIONAL GEOGRAPHICAL CONGRESS (STOCKHOLM)

By K. A. Salishchev

(Excerpts from Vestnik Moskovskogo Universiteta, seriya geografiya, 1961, No. 1, pp. 3-12)

(Abstract: Following are excerpts from a report read by Professor Salishchev on October 14, 1960, at a meeting of the Council of the Geography Faculty of Moscow University. The omitted part of Professor Salishchev's report is substantially the same as the report of the National Committee of Soviet Geographers, printed in Soviet Geography, April 1961, pp. 40-46. Professor Salishchev's report on the work of the Commission of National Atlases, of which he is chairman, is translated in full.)

*** Unfortunately many countries of Asia and Africa were poorly represented at the 19th Congress; for example, Indonesia, Iraq and the United Arab Republic had one delegate each. There were no geographers from the Chinese People's Republic. The presence of geographers from countries that had only recently thrown off the yoke of colonialism was to be welcomed. There were four geographers from Ghana, two from the Congo, one from

Nigeria and five from Senegal, but there were no Africans among them. A point should be made to expand scholarly representation at future geographical congresses.***

Increased participation by American geographers was evident at the Stockholm congress compared with the congress of Rio de Janeiro. There was a noticeable increase in the number of problem papers submitted by geographers of capitalist countries (especially the United States) and there were fewer papers on minor, particular topics than at previous congresses. However the latter included some papers of an openly reactionary character. (For example, a representative of the Vatican read a paper on the topic "Religious geography in the present-day methodology of the social sciences," which, in particular, "discovers" the existence of still another sphere -- the "theosphere" -- and establishes a "latitudinal variation" in the organization of the clergy.) A large number of papers at the Congress were devoted to questions of political, commercial and economic geography.

In this connection it should be pointed out that there were gaps in the topics covered by Soviet papers, which contained no reports related specifically to geographic problems of individual foreign countries or to problems of geographic education, which offers a useful field for publicizing Soviet ideas of middle-school education.

It should be noted that the Soviet delegation included 14 university geographers. The 15 papers that they read were received with evident interest by the Congress. This was a good test for Soviet university geographers, who contributed honorably in presenting the general condition of Soviet geography, its achievements and its broad prospects of development.

An especially important contribution to the work of the Congress was the research performed through international cooperation under the IGU program, and the special publications. Here we must come back to the work of the commissions. The Executive Committee singled out two of them as particularly effective -- the Commission on Periglacial Morphology under the chairmanship of Jan Dylik (Poland), of which Prof. K. K. Markov of the Soviet Union is a member, and the Commission on National Atlases, whose organizational and working center is at the Geography Faculty of Moscow University. The Geography Faculty prepared three volumes for the Congress -- the monograph Atlas nationaux (in French) and the volumes of articles Metody geograficheskikh issledovaniy (Geographic Research Methods) and Periglyatsial'nyye yavleniya na territorii SSSR (Periglacial Phenomena on the Territory of the USSR). The faculty also took active part in the preparation of the volume of articles Sovetskaya geografiya. I will now speak in greater detail about the Commission on National Atlases.

The 9th General Assembly of the IGU, at its meeting in Rio de Janeiro in 1956, established the Commission of National Atlases, instructing it: (a) to promote the publication and improved quality of national atlases and (b) to insure greater uniformity of atlases with a view to facilitating

comparisons and the use of atlases as source materials for future international maps of the world.

A detailed work program was worked out by the commission at a plenary meeting in the Geography Faculty of Moscow University August 11-20, 1958, in which 150 geographers and cartographers from 15 countries participated. The meeting listed as the commission's immediate tasks: the preparation and publication of research monographs giving in concise form a systematic review and analysis of national atlases already published or in work, and recommendations regarding their preparation: the organization of a bibliographical center; consultations on problems relating to the preparation of national atlases in individual countries; the organization of a secretariat of the Commission on National Atlases at the Geography Faculty of Moscow University. Soviet geographers assumed responsibility for implementation of Point (a).

A meeting of the commission August 8-9, 1960, had the following objectives:

(1) Discussion of the results of the four-year activity of the commission and their submission to the International Geographical Congress;

(2) Familiarization with the work on national atlases in various countries;

(3) Determination of the problems to be entrusted to the commission for the following four-year period (1961-64) and of the program of future activities of the commission.

Discussion of the results of the activity of the commission was facilitated by the fact that most of the results had beeen published and could be distributed among the participants.

The basic basic publication was Atlas nationaux, hixtoire, analyse, voies de perfectionnement et d'unification, prepared at Moscow University under the commission chairman and published in French by the Publishing House of the Academy of Sciences USSR. That volume sums up past experience in the preparation of national atlases, formulates criteria, outlines the structure and basic section of a national atlas and contains recommendations for the mathematical base, topics and content of the maps.

The Institute of Geography of the Polish Academy of Sciences submitted for the bibliography of national atlases a regular issue of its series Dokumentacja geograficzna titled "National atlases; sources, bibliography, articles."

One of the results of the activity of the commission was the numerous articles written and published on its instructions.

Noteworthy from the point of view of problem content are the articles by Prof. Edgar Lehmann "On the Problem Content of National Atlases" (1959) and by Prof. S. Rado and T. Bernat "The National Atlases of the Socialist Countries in the Service of the National Economy" (1959). The latter discusses the importance and the ways of utilization of national atlases in

solving problems relating to the geographical division of labor and the territorial distribution of production, as well as the role of national atlases in economic collaboration among countries of the Socialist camp.

Among the publications devoted to an analysis and grounding of the topics and content of individual sections of national atlases is the series of articles by Soviet cartographers published in Vestnik Moskovskogo Universiteta, seriya geografiya (translated in Soviet Geography, November 1960, pp. 56-61; May 1961, pp. 33-55). It is interesting to note that these articles were submitted to a thorough critical discussion on the part of Belgian geographers. The substance of the discussion was summarized by Prof. Omer Tulippe in the publication Le Comité National Belge de Géographie au Service de la Commission des Atlas Nationaux de l'U.G.I. and was utilized in drafting a program of Belgian atlases of national importance. We have here a fine example of international collaboration.

Especially useful for an exchange of experience and for publicity was the presentation and discussion at plenary meetings of the commission of concrete studies relating to the preparation of national atlases. This sort of preview of national atlases contributed to the dissemination of constructive experience and the noting of shortcomings.

An important element in the work of the commission was the exhibition of national atlases, which demonstrated clearly the broad scope of work on national atlases and furnished the occasion for an additional and very useful exchange of experience. There were 26 exhibiting countries: Australia, Austria, Belgium, Brazil, Britain, Hungary, East Germany, Denmark, Israel, India, Spain, Italy, Canada, Kenya, Congo, Morocco, Mexico, USSR, United States, Finland, France, West Germany, Czechoslovakia, Sweden, South Africa and Japan.

Discussion of the four-year activity of the commission showed that the work program adopted in 1958 had been completed. However, one of the most complex problems before the commission -- the drafting of recommendations for unification of the principal maps of national atlases -- was deferred until the following period. Participants in commission sessions offered many valuable suggestions for unification and improvement of atlases as a whole and of individual groups of maps, and proposed several new tasks for the commission. The idea of the desirability of including regional atlases in the sphere of activity of the commission was repeatedly emphasized. The suggestions were incorporated in the following resolution, which was unanimously adopted:

"The Commission on National Atlases met in Stockholm under the chairmanship of Prof. K. A. Salishchev in a plenary meeting on the occasion of the 19th International Geographical Congress. At the end of the meeting the commission adopted the following decisions:

1. Having taken cognizance of the report submitted by the chairman, the commission approves the content of the report.

2. The commission recommends expansion of its international activity through constant strengthening of ties with all countries with a view to adding to the list of completed atlases and intensifying work on the preparation of new atlases in accordance with the principles established by the commission.

3. The commission proposes to adopt the following objectives for the next four-year period (1961-64):

(a) Unification of the programs and the legends of the principal maps of national atlases;

(b) Analysis of published regional atlases, and study of the measures taken in various countries to utilize national atlases and assure their homogeneity;

(c) Study of ways of making wider use of the data of national atlases in international cartographic projects;

(d) Study of the problem of keeping national atlases up to date, especially in the case of rapidly changing elements.

4. The commission expresses its gratitude to countries that assured the financing of their national atlases, and recommends that other countries discuss this problem attentively and with good-will.

5. The commission, having been renewed for the next four-year period, should regard as its main objective the formulation of a work program based on the preceding recommendations."

The General Assembly of the International Geographical Union extended the term of the Commission on National Atlases for the following four-year period. (The membership of the commission is: K. A. Salishchev, chairman; Carleton P. Barnes (United States), Eduard Imhof (Switzerland), Sandor Rado (Hungary), Omer Tulippe (Belgium), Shiba Prasad Chatterjee (India). The list of corresponding members has been expanded.)

What conclusions are to be drawn from the review of the activities of the 19th Congress? What should be the objectives of Soviet geographers, particularly university geographers?

One of the principal aspects of the work of the congress was the greater activity of the Soviet delegation and the delegations of other Socialist countries in keeping with the high ideals of development of progressive trends and ideas in geographic science and the strengthening of international scholarly contacts as one of the paths to mutual understanding, so important in our struggle for peace. This greater activity should continue in all our work, particularly in preparations for the next geographical congress. There should be a further increase in the general level of Soviet research and a strengthening of its methodological base; Soviet geographers elected to serve in the commissions of the IGU should insure a high level of work. This applies not only to them personally, but to all members of this faculty, with a view to further raising the prestige of Soviet geographical science. I would like to recall that the National Committee of Soviet Geographers suggested that moral responsibility for the successful work of each commission should lie in its chairman and the national committee of the respective country with a

view to insuring scholarly and organizational support for the work of each commission. A group that nominates its members for service in international scientific organizations should all the more not only assume moral responsibility for the work of its representatives, but assist them by taking direct part in their work. Such participation should be made part of the research program of the faculty and be controlled as such. It may be asked whether such an arrangement does not divert efforts from the fulfillment of the faculty's seven-year research plan. The answer is no, mainly because research along IGU lines is just as useful and just as closely related to geographic work designed to assist the development of the economy and culture of the Soviet Union.

A second objective emerges from the general trend of future expansion of the IGU as newly independent countries join the organization. We should establish close ties with geographers of those countries and render them all kinds of help. Such assistance could include consultations regarding the organization and execution of geographic projects (such as the consultations by the Geography Faculty of Moscow University regarding the national atlases of several foreign countries), the training of personnel, the planning of teaching programs and of monographs on the geography of foreign countries, special research projects, and so forth. It is evident that for that purpose not only the channels of the IGU should be used, but bilateral contacts should be established, especially agreements on scientific and technical assistance.

ECONOMIC GEOGRAPHY AT THE 1960 INTERNATIONAL GEOGRAPHICAL CONGRESS

By Yu. G. Saushkin

(From Vestnik Moskovskogo Universiteta, seriya geografiya, 1961, No. 1, pp. 13-20)

(Abstract: The author compares the scope of economic-geography papers at the Rio de Janeiro and Stockholm congresses, discusses William William-Olsson's book on Stockholm, and analyzes a number of congress papers with an economic-geographic content.)

Four years ago, on their return from the 18th International Geographical Congress at Rio de Janeiro, Soviet geographers commented on the large number of papers (about 140) with an economic-geographic content that had been given at the congress. There was no doubt that economic geography was the "queen" of the Rio de Janeiro congress. Papers with an economic-geographic content were read in six sections: economic geography, historical and political geography, geography of population and settlements, human geography, agricultural geography and regional geography (Yu. G. Saushkin, "Problems of economic geography at the 18th International Geographical

Congress at Rio de Janeiro," Vestn. Mosk. un-ta, ser. geol., biol., pochv., geog., 1957, No. 2). At the 19th congress, which opened August 6,1960, problems of economic geography once again held the center of attention. This time papers of an economic-geographic content were read at the sections on economic geography and human geography, and clearly predominated in the section on applied geography; in addition economic geographers delivered papers in the section on methodology and bibliography. Papers with an economic-geographic content were also read at commission meetings -- on a world land use survey, on a world population map, on the arid zone, on humid tropics, on teaching of geography in schools, and so forth, but many of the commission papers were not taken into account in the congress program and it is therefore difficult to analyze them.

Two of the congress sections were in a real sense economic geographic -- the sections on economic geography and on human geography. The line of division between the two sections was quite arbitrary. As it turned out, however, the first of the two contained the more constructive papers of Soviet, Polish, Hungarian, Rumanian, Bulgarian, and also of American economic geographers, while the second was devoted to papers related genetically to the French school of "géographie humaine." As a result papers were read predominantly in English in the section on economic geography, and in French in the section on human geography.

A special word is necessary regarding the section on applied geography. In many countries there is now a desire on the part of certain geographers to find new ways of development for geography, particularly economic geography, to bring science closer to practical needs, and to make geography more constructive and effective. Few people are still satisfied with the old descriptive anthropo-geography, and there is evident dissatisfaction with the traditional economic-geographic work that characterizes the distribution of individual segments of the economy and is usually quite removed from genuine geography. A substantial number of geographers therefore organized a separate section on applied geography, devoted to the discussion of integrated economic-geographic problems of practical significance, going far beyond traditional trends in geography.

According to the published program (19th International Geographical Congress, Norden, 1960, Program of Congress Sessions, Stockholm, Aug. 6-13, 1960), there were 104 papers with an economic-geographic content submitted at Stockholm. Some of these were not delivered, others were replaced, but that does not substantially change the ratios between the various branches of geography represented at the congress.

The number of economic-geographic papers at Stockholm compares as follows with their number at Rio de Janeiro (Saushkin, op. cit.):

	Stockholm	Rio de Janeiro
General problems of economic geography	27	7
Geography of industry	15	11
Geography of transportation	6	11
Geography of agriculture	15	37
General problems in the geography of population	14	7
Urban geography	11	28
Geography of rural population	8	18
Geography of population migration	2	13
Historical geography	4	4
Other topics	2	2
Total	104	138

One is struck in the first place by the sharp increase in the number of papers dealing with general problems in economic geography, including a large number of papers (about 20) on economic regionalization and regional planning. Four years ago there were no papers dealing with these topics. There is thus evidence of a considerable interest in regionalization and related regional planning, the most synthetic and the most important topics in present-day economic geography.

Despite the decrease in the total number of economic-geography papers, there was a rise in the number of papers dealing with the geography of industry. There was a sharp drop in the number of agricultural topics resulting both from the change in the site of the congress (in agrarian Brazil there is considerable interest in problems of agricultural geography) and, in part, from the fact that the land-use papers, which are of narrower significance (there were more than 30 at the previous congress), were presented at meetings of the land-use commission rather than in sectional meetings.

There was also an obvious drop in the number of urban-geography papers. The 1956 congress heard many papers on specific cities, while at the 1960 congress the smaller number of papers were more general in character.

On the opening day of the Stockholm congress, at a plenary section, Prof. William William-Olsson of the Stockholm School of Economics, delivered a talk with an economic-geographic content on the topic "Stockholm, Structure and Development." The talk provided an excellent picture of this great and interesting city. A book on the same subject, written by the speaker and distributed to congress members on the opening day (W. William-Olsson, Stockholm, Structure and Development, Uppsala, 1960), offered even deeper and thorough information about the city. Many excursions and walks through Stockholm made acquaintance with the Swedish capital more concrete and offered geographers an entirely adequate impression of its appearance.

Present-day Stockholm is a large city, whose population, including satellite towns within its official city limits, is more than 1,000,000.

The most distinctive aspect of this large industrial city is the abundance of water areas and of green parks and woods. It is said about some cities that nature penetrates within its boundaries. Such a city, for example, is our lovely Kiev. In the case of Stockholm, it may be said that city itself penetrates into nature, organically merging with it. The visitor to the Swedish capital clearly feels the presence of the natural landscape of the middle part of the country, and the stone of the city buildings does not screen nature, but, on the contrary, underlines its distinctiveness. Stockholm is even closer to nature in the summer, when the inhabitants of the Swedish capital seek out the countless islands of the Baltic and Lake Malaren, with their 50,000 summer cottages, or spend their vacation on their private boats, of which the people of Stockholm seem to have almost more than automobiles.

Out of Stockholm's million population, about 500,000 are employed in enterprises, institutions and as domestic help. There are few domestic servants, only about 14,000, and most of the households have none. Most of the employed part of the population works in industry (about 140,000). Metal fabrication (with machine building) and printing have the largest number of employes. About 50,000 persons each are employed in urban transportation and in construction. Stockholm is a large banking and commercial center of world importance, and it is therefore no accident that more than 85,000 persons are in "business" (together with retail trade, restaurants and hotels, more than 150,000), which is far more than in government agencies (40,000) or in health and education (31,000).

Various parts of Stockholm differ sharply from one another in their urban functions and the composition and density of population. This is well shown in William-Olsson's book by means of many map diagrams, some of which represent urban activities over time. There are, for example, map diagrams showing the growth of the built-up area (in 1850, 1895, 1930, and 1950), the number of children per 1,000 population (1850, 1895, 1930), which clearly show a sharp reduction in the number of children in Stockholm (1950 data are not even shown), and so forth. Using the method of cartograms and cartodiagrams, William-Olsson shows sharp social differences within Stockholm in the form, for example, of the distribution of per capita income by city blocks, or the number of votes cast for various parties (including the Communist party) at elections (by voting precincts). Of special interest are the map diagrams showing by means of symbols the distribution on a city map of government agencies, educational institutions, shopping (the principal shopping streets are shown for several dates), theatres, hotels and so forth. The distribution of industrial enterprises is shown in special detail by means of dots and isolines. The printing industry is concentrated in the center of the city while the metal-fabricating industry lies near the city margins. In the final part of the book, William-Olsson shows the internal functional differentiation of Stockholm as of 1865, 1910 and 1960, locating government agencies, business blocks, shopping streets, amusement centers (theatres, motion-picture houses etc.), areas of the printing and garment industry, railroad lines and stations.

The appearance of Stockholm has greatly changed in recent years. There are now several new satellite towns linked with the city of Stockholm by convenient transportation, including subway lines. The planning and building of the satellite towns, their transportation systems, the restriction of all vehicular traffic in some zones, the use of existing relief, and the careful maintenance of trees -- all these aspects deserve attention. The business section of Stockholm is in course of reconstruction. Large blocks of fine houses are being razed and being replaced by an "Americanized" city center consisting of a series of 20-story steel-and-glass boxes aligned in parallel. This new city center is in complete disharmony with the lovely appearance of the rest of Stockholm and its natural site.

William-Olsson's talk and book showed us not only the city in which the congress was taking place, but the high level of Scandinavian, especially Swedish, geographic science. It should be noted that the hospitable Scandinavian hosts themselves presented virtually no papers at the congress, making available the time to their guests who had come together from many parts of the world. Therefore we can judge the quality of the geographic research of Scandinavian scholars not so much from their scientific papers as from the many publications, including fine scholarly guidebooks, that were specially prepared for the congress and published in English with a large number of maps, diagrams and photographs.

The work of the congress sections began August 7. It is difficult to provide a complete review of all the papers in a short article. At the center of attention in the section on economic geography were, as a rule, the papers of Soviet geographers (together with those of other Socialist countries -- Poland, East Germany, Hungary, Bulgaria) and the Americans. It has become quite clear that despite all methodological differences economic geography has assumed its greatest importance both in the Socialist countries, mainly the USSR, and in the United States. Peaceful economic competition between the USSR and the United States also affects the field of economic geography since progress in that field makes it possible to improve the territorial organization of productive forces, which in turn leads to a higher productivity of social labor.

Unfortunately the National Committee of Soviet Geographers evidently underestimated the importance of economic geography in the development of present-day world geographic science and in the scholarly competition between Soviet and American economic geographers. Therefore only six papers by economic geographers of the Soviet Union were presented at the congress: V. V. Pokshishevskiy (in the section on human geography), S. V. Slavin (in the section on polar and subpolar geography), M. M. Zhirmunskiy, V. A. Krotov, I. V. Komar (with four co-authors) and the author of the present article (in the section on economic geography). Economic geographers of other Socialist countries read twelve additional papers, of which half were by Poles. All the Socialist countries thus presented 18 papers while the economic geographers of the United States read 40. Despite the numerical superiority of the American papers, those of the economic

geographers of the Socialist countries made a sufficiently strong impression, much stronger than at the preceding congress. I should also like to mention the attention and, in general, the good-will that American scholars demonstrated toward the Soviet papers and the papers of representatives of other Socialist countries.

Among the Soviet papers should be mentioned those by V. A. Krotov (on new economic regions in Eastern Siberia) and S. V. Slavin (on the industrial development and the natural resources of the Far North of the USSR). They demonstrated the achievements of the Soviet people in the industrialization of once undeveloped parts of the Soviet Union and the natural environment that hampers large-scale urban, industrial and transport construction. In addition to interesting factual data on the new industrial nodes of Eastern Siberia and the Far North, these papers contributed much toward an understanding of the integrated development of the economic regions of the USSR.

One of the Soviet papers (by Yu. G. Saushkin -- Editor's Note, S. G.) was entitled "Economic geography -- a science dealing with territorial complexes of productive forces." It described the Soviet theory of development and the typology of territorial production complexes. Congress members were told, in particular, about the remarkable work of N. N. Kolosovskiy on the problem of energy-production cycles and about the practical significance of an integrated approach to the planning of development of the economic regions of the USSR. The large number of questions that were asked the speaker by leading American scholars -- R. Hartshorne, W. Isard, and others -- were evidence of a lively interest in the Soviet theory of territorial production complexes and economic regionalization and the new fertile ideas of Soviet economic geography.

Problems of economic regionalization and the development of territorial complexes of productive forces were also at the focus of attention among papers from other Socialist countries. K. Dziewonski and S. Leszczycki of Warsaw read a paper on the subject "Geographical studies of economic regions in Central-Eastern Europe -- problems and methods," in which they reported on the results of the International Conference on Economic Regions held by the Polish Academy of Sciences in Kazimierz May 29-June 1,1959, and discussed the main lines of future research. Professor Dziewonski read an interesting paper on "Problems of the regional structure of Poland," illustrating it with original economic maps. Using the specific example of the Cottbus district, Professor H. Kohl of East Berlin described a method of integrated economic-geographic research for purposes of regional economic planning. Professor K. Marinov devoted his paper to the economic regionalization of Bulgaria. An outstanding paper, both in content and in form, was read by the young Hungarian geographer Gyula Bora, who investigated the relationships between the geography of energy resources and the geography of industry in Hungary.

The economic geographers of the Socialist countries thus presented in-

teresting and important papers (from the point of view of theory and practice) on major topics that had not been touched on at all at the preceding congress.

Several American, Canadian and, in part, British papers bore evidence of great interest in problems of economic regionalization and the formation of territorial production complexes, in regional planning and in the application of mathematical methods to economic geography, which are emerging from the development of a planned Socialist economy and new technology in many countries of Europe and Asia.

To be mentioned first is a special talk, not scheduled in the program, by Richard Hartshorne, the leading American theoretician in the field of geography, dealing with the need for taking account of the growth of new technology in geographic research. Hartshorne pointed out that the time had come for geography, as a science describing and mapping the appearance of the earth, to use a new engineering approach. However, the paper was declarative in character and gave the impression that the speaker was merely "renovating the front of the building" without changing any of the concepts expounded in his well-known theoretical works The Nature of Geography and Perspective on the Nature of Geography.

In my opinion the most interesting paper in the field of economic geography was the one by Walter Isard of the University of Pennsylvania (in the section on applied geography) dealing with the construction and practical utilization of models of economic regions (industrial complexes) for locating new enterprises. In the program the paper was titled "Regional science techniques applicable to geographic studies." Isard is head of the Regional Science Association, which since 1955 has been publishing annual Papers and Proceedings. Isard came into the field of economic geography from higher mathematics. He is 41 years old (his father, incidentally, was born in Kiev and was graduated from the University of St. Petersburg, but emigrated to the United States in 1906 during the period of intensified reaction in Czarist Russia) and is well known in the United States as the author of several important books, a large number of articles and computations of practical significance for the location of industrial enterprises. His book Location and Space Economy (New York - London, 1956) still shows evidence of strong influence of West German authors of Standort theories, especially A. Lösch, but Isard's more recent books (Methods of Regional Analysis, and others) show that he is moving increasingly away from the Lösch concept of market areas toward the concept of producing areas, as reflected in his paper at the Stockholm congress.

Isard's paper was immediately followed, as if it were a continuation, by a paper by Clark N. Crain (University of Denver) on the subject "A prediction model for population impact." It dealt with the calculation of changes in the numbers and structure of population, urban construction, transport, the construction of schools and hospitals and the opening of new stores in connection with the appearance of new industrial enterprises in a region (node). The paper of Richard L. Morrill (Northwestern University) was devoted to the problem of constructing models of inter-regional movements.

Among the constructive papers was also the interesting paper by Victor Roterus (Washington, D. C.) on the topic "The development of the planned industrial park concept in the United States," delivered in the section on economic geography. It was illustrated by slides showing the construction of large special transportation parks in industrial centers of the United States that process the bulk goods of industry. The paper had undoubted practical value.

These new constructional, computational, technical-economic and econometric tendencies in American economic geography are far from being shared by all geographers in the United States. In talks with American scholars in the corridors of the congress, I heard negative comments about the "schematic constructivism" and "technicism" of Isard's work, just as I felt a skeptical attitude among geographers of the middle and younger generations toward the views stated in American Geography: Inventory and Prospect, especially with regard to the concept of subjectivism in regionalization, which is so evident in that volume. There is no doubt that a certain "stratification" is taking place among American economic geographers; there are conceptual conflicts, there is dissatisfaction with the present-day methodology of American geography, and there is a desire to create and develop new concepts closer to life and practice. This explains the warm, well-intended interest in Soviet economic-geographic research that is evident among the greater and more progressive part of American scholars.

The Soviet economic geographers awaited with interest the papers of two American geographers devoted to the economic geography of the USSR: one by Theodore Shabad about the location of the synthetic rubber industry, and the other by Allan L. Rodgers (Pennsylvania State University) about coking-coal movements. Both speakers used a great deal of factual data gathered from many Soviet sources and compiled several map slides, but they unfortunately limited themselves to establishing facts and did not take account of the Soviet method of economic-geographic analysis and synthesis that makes it possible to uncover further regularities in the geography of industry of the Soviet Union as a whole and its economic regions.

American geographers presented also quite a few papers about other countries, and it was certainly unusual to see how the audience fell silent on one occasion when, in the section on applied geography, it was a Canadian geographer, Donald Q. Innis of Kingston, Ontario, who delivered a bold and well documented paper about the way capitalists of the United States recklessly use Canadian resources for their own enrichment. The paper (titled "North American use of Canadian resources") clearly expressed the desire that the Canadian nation in the future no longer allow capitalists of the United States to lord it in such an uncontrolled fashion in Canada. Innis' paper made a strong impression.

The congress in Stockholm strengthened the international contacts of Soviet economic geographers. Of great importance was the establishment at the congress of a new Commission on Economic Regionalization. It

should be noted that this was the first economic-geographic commission set up within the framework of the IGU. The chairman of the new commission is S. Leszczycki of Poland, and geographers of the United States, the USSR, Yugoslavia and France are serving as members. (The IGU Newsletter, 1961, No. 1, also lists a West German member -- Editor, S.G.). Ideas regarding economic regionalization will thus continue to develop, and in four years, at the 20th International Geographical Congress in London, problems of economic regionalization, the construction of production models, and regional planning will undoubtedly occupy one of the leading places.

AN APPROACH TO INTEGRATED PHYSICAL-GEOGRAPHIC DESCRIPTION OF AN AREA

By Yu. K. Yefremov

(From Izvestiya Vsesoyuznogo Geograficheskogo Obshchestva, 1960, No. 6, pp. 512-514)

(Abstract: The author proposes an outline for the physical-geographic treatment of an area, emphasizing the integrative aspect of geography instead of the widespread systematic approach. He considers integration a distinctive characteristic of geography and seeks to eliminate the usual enumeration of systematic factual data.)

The formulation of a method for integrated geographic description of an area has been one of the neglected aspects of geography. Many geographic descriptions suffer from inadequate integration and an excessive variety of approaches and methods. Such variety does not derive from the wealth and diversity of the content, but rather from a methodological confusion resulting from the absence of uniform yardsticks and a lack of successiveness. This results in the incomplete uncovering of universal relationships between phenomena, which is a major flaw in geography (especially in methodology).

A great deal might be learned from the experience of the great masters of the past as well as from a special methodological analysis of successful present-day geographic studies. But sometimes such success is explained simply in terms of the ability of the author. The false impression is created that ordinary authors in the normal process of training cannot master the "secrets" of good geographic description. Actually the merits and the shortcomings of available and planned geographic descriptions are quite easily submitted to objective analysis. These qualities can be determined through examination of a large number of existing examples, some for purposes of imitation, others to establish how not to construct geographic descriptions. Such an examination might furnish the basis for a course in the methodology of geographic description, for which there has long been a great need.

We must remember that the existence of methodological recommendations and standards, for example, in cartography, helps ordinary cartographers to make good maps. In other words, we can and must be able to raise the quality of the great mass of geographic area descriptions.

One shortcoming of many present-day physical-geographic descriptions is the lack of balance between the general and the regional sections, where integrated presentation is achieved mainly in the regional section and the general section consists essentially of a systematic survey of the components of the landscape. The general section thus becomes a mechanical mixture of virtually unrelated chapters on the area's geology, geomorphology, climate, hydrology, soils, plants and animals.

We know that the tendency of a science to break down and separate into increasingly specialized subordinated sciences also creates its opposite: a need for generalizing sciences, sciences that deal with relationships between phenomena. Geography is such a generalizing science dealing with the landscape sphere of the earth, a science dealing with the relationships between the landscape components. For geographic description to break down into systematic chapters is a step backward and contrary to the spirit of integrated geography. A striving for integration is a progressive tendency in present-day geography.

Let us consider first, as a way of furthering the integration of general sections of geographic descriptions, the inclusion of several integrated chapters into the structure of those sections.

The following outline of the general section of a physical-geographic description can be recommended as an example:

1. The geographical location of the area not only in terms of geographical coordinates, but with respect to the system of landscape zones and tectonic structures, with relation to centers of activity of the atmosphere and climatological fronts, and to foci of formation and paths of migration of flora and fauna; proximity to seas and oceans or, on the contrary, remoteness from large water bodies; exposure of slopes with regard to points of the compass, prevailing winds and currents; the presence of isolating barriers, and so forth; the economic-geographic location and its effect on man's activities in seeking to change nature.

This section would contain a large part of the systematic characteristics of individual components of the landscape with interpretation of the principal causes of their distinctiveness.

2. A general picture of the landscape-forming factors (landscape components) and their causal interrelationships. This point is especially important for descriptions of large areas and can be omitted in the case of smaller regional subdivisions.

3. The role of individual components in the landscape. Here the discussion would cover the rest of the systematic material, which can best be treated by grouping related factors: A. Geological-geomorphic (underlying rocks and land forms); B. Hydro-climatic (climate and the waters of land and sea); C. Soils-biogeographic; D. Sociogenous (society's activities in changing nature).

The advantages of a grouping of the components is best illustrated in the case of rocks and land forms. A separate description of these components leaves the problem of what to discuss first, the rocks or the land forms. It is difficult to understand geological structure without having a general idea of the land forms; on the other hand, the history of the land forms, the dynamics of their development and the role of individual relief-forming factors cannot be discussed before a description of the geological structure. The way out lies in the joint discussion of geological and geomorphic data. That does not mean complete interweaving: the reader must be able to distinguish to what extent the described processes are rock-forming, and to what extent relief-forming, i.e., geomorphic.

The description should, of course, be started with the land forms, but that does not mean that "in the beginning there was relief." The major surface irregularities, such as mountains, plains, ranges, valleys, serve primarily as a system of "addresses," a kind of network of streets and alleyways with which the reader must be familiar before he can understand the distribution of structures and other geological aspects. All that is needed is an idea of the external aspect of the relief, its horizontal and vertical breakdown (orography and morphography). But even here the principal morphostructural units can be introduced incidentally; a geological-geomorphic synthesis should be felt from the very first pages.

This is followed by a description of the underlying rocks. However, in contrast to purely geological description, this "geographical geology" should emphasize data on stratigraphy, lithology and tectonics, all of which are important: (a) for basic paleogeographic interpretation, (b) for an evaluation of the rocks' relief-forming importance, and (c) for an understanding of the origin and the laws of distribution of mineral resources.

On the basis of a description of these lithological-stratigraphic and structural relationships, it is easy to proceed to a discussion of the paleogeography of the area. In geographic studies, in contrast to geological treatments, it is extremely important to focus the reader's attention on those events or characteristics of the paleo-landscape that had the greatest influence on the present-day relief and landscape, including the economic-geologic potential of the area.

The significance of paleogeographic influences on the present-day landscape increases as one approaches the more recent stages in history. A decisive role in the formation of major features of the present-day relief of most accidented land areas is played by two processes: (a) long-term

leveling of the peneplanation and pediplanation type; (b) differentiation of the macrorelief by neotectonic movements. This means that any description of recent geological history must include both rock-forming and the closely related relief-forming processes. It is at this point that geological-geomorphic synthesis should reach its greatest depth and completeness. The geological-geomorphic discussion can end with a few paragraphs on land-form types and geomorphic regionalization;making extensive use of the previously presented geological material.

Such an approach not only makes it possible to avoid separate geological and geomorphic chapters, but insures mutual enrichment of the material on underlying rocks and land forms in the very process of joint treatment. Similar examples could be cited for other groups of components (the hydro-climatic chapter, the soils-biogeographic chapter, and so forth).

4. The history of the natural environment (paleogeography in the broad sense) as interpreted directly from an analysis of the history of development of the underlying rocks and the land forms, treated stage by stage without any systematic breakdown.

5. The characteristics of the present-day dynamics of landscape-forming processes. This section is important in the description of small areas, for example in analyzing the geochemical properties of the landscape.

6. A general picture of the natural resources. Within this section the material can be grouped by categories, say, minerals, water, soils, forests, and so forth. However, alone the concentration of these data in one chapter makes it possible to seize at a single glance the economic potential of the natural environment, which is especially important for the contents of the following two sections.

7. An evaluation of the influence of the natural environment on the economy. Here also one can resort to an item-by-item enumeration of the influence of individual environmental components on the economy, as Yu. G. Saushkin did in his Vvedeniye v ekonomicheskuyu geografiyu (Introduction to Economic Geography; 1958). But it would be more useful to discuss the influences by groups of components and by individual areal combinations of such influences, and to discuss the way the influences change with economic development.

8. The conservation, enrichment and transformation of nature. The integrated character of this section underscores especially the need to talk about a single system of measures aimed at the conservation of nature as a whole and at the expanded reproduction of renewable natural resources. The conservation of individual aspects of nature is the concern of individual biological and geographical sciences. Geography, as the science that deals with relationships between phenomena, should make it its business to coordinate the individual nature-conserving measures. This also applies to questions of enrichment and transformation of nature since changes in individual components always produce important changes in the landscape as a whole.

9. Forecasts of the future development of nature. This is a logical continuation of the history of the natural environment, especially useful in the planning of major transformation programs, and is therefore best discussed after the chapter on the transformation of nature.

10. A general picture of landscape contrasts -- an important link between the general and regional parts of the description. Without that link any system of regionalization would seem arbitrary and subjective. The discussion should take account of the entire complex of areal differences in the character of individual components and groups of components of the landscape, the degree of such contrasts, the existence of coordinate units of various ranks, and so forth. This section, in other words, should contain a justification for the following system of regionalization and the description of landscape types. The typological description is actually the beginning of the regional description. But, from a logical point of view, it is preferable to end the general part of the description with this section because a typological analysis constantly refers back to the repetition of features in the area as a whole.

The construction of the general part of a physical-geographic description along the lines discussed above eliminates overloading of the text with systematic factual data and fixes the reader's attention on the basic problems in physical geography -- the historically developing relationships between phenomena in the landscape sphere of the earth, specifically the relationships between nature and society.

The proposed outline makes it possible to leave the entire physical-geographic description to physical geographers without recourse to co-authorship by systematic specialists. With such an outline the general sections of geographic description become really general geography and need no longer be called "systematic."

The same type of integrated treatment should be carried out in the regional part of the geographic description. This can be achieved, in the first place, by stating on the basis of what combinations of features each region has been delimited, i.e., how it differs from adjoining areas and by what unique combination of features it is internally united.

Another recommendation that applies to the regional part is the grouping of landscape components (geological-geomorphic, hydro-climatic, soils-biogeographic, sociogenous) and the determination of relationships between groups and the role of each in the landscape.

An integrated regional treatment often suffers from the authors' desire to distribute the material on the significance of individual components among the various taxonomic levels of the regional classification, for example, to discuss tectonics only at the country level, zonal features only at the province level, and so forth. However the natural environment can be reflected with greater completeness if the entire combination of landscape-forming

factors is discussed at each taxonomic level. This does not mean, of course, that common features cannot be placed outside a brace in constructing legends for regionalization maps.

The foregoing principles, with appropriate adjustments, could also be useful in working out a method of economic-geographic description, where "systematization" also often interferes with the integrated treatment of an area.

The use of the proposed principles (subject to verification in practice and necessary corrections) can help geographers bring out more fully the character and distinctiveness of their science by demonstrating the self-dependence of its subject matter and method.

THE TRANSFORMATION OF THE CASPIAN SEA

By S. N. Bobrov

(From Geografiya v shkole, 1961, No. 2, pp. 5-15)

(Abstract: The author reviews the problem of the level fluctuations of the Caspian Sea, particularly the steady drop since 1929. The drop in level is affecting many key sectors of the regional economy. Among several remedial schemes is a plan for diverting the rivers of northern European Russia to the Caspian, and a project for a localized regulation of the level of the Caspian Sea.)

In terms of its physical conditions and economic significance the Caspian Sea occupies a special place among the water bodies of the Soviet Union. Its drainage basin covers an area of 3.5 million square kilometers, or almost one-sixth of the USSR. The population of the basin exceeds 60 million.

The Caspian Sea is the largest inland body of water in the world. Its characteristic feature is considerable fluctuations of the water level.

The Caspian Sea has important natural resources of considerable significance for the Soviet economy. These resources yield tens of billions of rubles of income. Prior to the intensive drop of water level that began in 1929, the Caspian Sea yielded up to 40 per cent of the Soviet fish catch. It yields up to 90 per cent of the world sturgeon catch and 95 per cent of the black caviar. A valuable food fish, the Siberian whitefish, is found only in the Caspian Sea. Most important from the point of view of fisheries is the northern part of the sea; the fish catch in the delta of the Volga River is also large. It is the combination of the Volga River and the Caspian Sea that accounts for the abundance of fish. More than 100,000 Caspian seals

are caught each year. Among the large fish-processing plants in the Volga delta are the Oranzherei plant, the Astrakhan' plant named for A. I. Mikoyan, the Astrakhan' redfish plant, and others. These plants process hundreds of thousands of tons of fish a year. There are hundreds of fisheries along the coast. The river deltas and several inlets of the Caspian Sea furnish excellent hatchery sites.

The Volga delta is covered by extensive reed growths that will furnish the raw material for a paperboard mill under construction at Astrakhan'. There are many saltworks along the coasts of the Caspian Sea, notably the sodium sulphate fields of the inlet Kara-Bogaz-Gol. The Caspian Sea is also known for its petroleum deposits, both on land and off shore.

The sea plays an important role as a transport route. Its traffic amounts to 40 per cent of all the maritime traffic of the Soviet Union. The Caspian Sea is linked by inland waterways with the Black Sea, the Sea of Azov, the White Sea and the Baltic Sea. The Caspian Sea serves five of the Soviet republics as well as Iran. Astrakhan' and Baku are the largest Soviet ports in terms of freight turnover. The ports of Krasnovodsk and Makhachkala are also important.

The Caspian Sea moderates substantially the climate of the coastal regions, protecting them against the influence of the desert. An important part in the Soviet economy is played also by the agriculture of the Caspian region, with its orchards, melon gardens, vineyards and animal husbandry.

The Problem of the Level and the Contours of the Caspian Sea. The level of the Caspian Sea has been subject to considerable fluctuations on which the entire regional economy depends. The Caspian has undergone fluctuations since antiquity. This is shown, for example, by the recent emergence in Baku Bay of the ruins of the towers of the ancient fortress of Karavan-Saray; the reappearance of remains of forests, in the form of stumps of the smooth-leaf elm, in the Lenkoran' area in 1956; the discovery of marine sediments at considerable distances from the present shoreline, and so forth.

These fluctuations of the Caspian Sea level depend mainly on climatic changes that have their origin in periodic fluctuations of solar activity and the resulting general circulation of the atmosphere.

B. A. Apollov suggested in 1936 that another factor, in addition to climate, in the Caspian Sea fluctuations was man's activity in the sea's drainage basin.

For an equilibrium in the level of the Caspian Sea to be maintained, the gain in the water balance (precipitation on the surface of the sea, discharge of tributary streams and underground discharge) must be equal to the loss (evaporation from the surface of the sea and runoff into the Kara-Bogaz-Gol). Such an equilibrium existed on the average in the period 1839-1929. The average annual gain of water during this period was 416.3 cubic kilometers

(stream runoff -- 339.5; precipitation -- 71.3; underground discharge -- 5.5) and was equal to the annual loss of water (evaporation from the surface of the sea -- 394.1, and runoff into the Kara-Bogaz-Gol -- 22.2). Since 1929 the annual loss has exceeded the annual gain and the sea level has been dropping.

This phenomenon can be explained both by a general warming of the climate and by man's activity in the drainage basin. Both the warming and man's activity (increase in the sown area, snow-conservation measures, construction of reservoirs, and so forth) have reduced the runoff of streams into the Caspian Sea, particularly in the Volga River, which contributes 77.8 per cent of the total stream discharge. Since 1929 the Caspian Sea level has been dropping especially rapidly, and is now lower by almost 2.5 meters. It has now reached the lowest level in the last 350 years. In general, as B. A. Apollov has established, the Caspian has experienced even lower levels.

The reduction in level by 2.5 meters has produced major changes in the morphometry of the sea and its hydrometeorological regime. These changes have been especially pronounced in the northern part of the sea and in all shallow bays and gulfs.

The average long-term area of the Caspian Sea has been 422,000 square kilometers (including the Kara-Bogaz-Gol), and its volume 75,500 cubic kilometers. The present area of the water surface is 370,000 square kilometers. Despite an increase in the length of the shorelines of islands, the over-all length of the Caspian shoreline has decreased. For each meter of level drop, the total volume of the sea is reduced by 0.5 per cent, and the volume of the shallow northern part by 17 per cent. Since 1929 the average depth of the northern part has dropped from 6.1 to 5.4 meters. The level drop in the last 30 years has resulted in a reduction of 960 cubic kilometers of the total water volume, which is almost equal to four years' discharge by the Volga River.

It would take all the tributary streams of the Caspian Sea 300 years to fill the sea basin. However, the volume of the northern part of the sea is so small that the Volga alone could fill it in three years. This shows the great influence the Volga has on the life of the northern part of the sea.

Changes in the contours and in the water area of the Caspian Sea have been especially significant in its northern part (Fig. 1, p. 50).

In the northern part of the Caspian Sea the water has retreated from the shallow Kaydak Gulf, and in part from the gulfs of Sineye Mortso and Komsomolets; in the southern part the Gasan-Kuli Gulf and other shallow gulfs and bays have been left dry. The area of other gulfs and bays has been greatly reduced. On the site of Kaydak Gulf and, in part, Komsomolets Gulf (the former Mertvyy Kultuk) there now extends a silvery-white salt desert. B. A. Fedorovich, Soviet desert explorer, has described the scene

as follows: "Here is a mirror-like salt flat, blinding in the sun, on which, in the fullest sense of the word, there is nothing to arrest the eye. Only here and there, along the shores, there are sharply defined, straight or intersecting or even spiral lines, the striations left by former ice floes scraping along the bottom of the shallow sea." Newly published maps now show salt flats on the site of former gulfs. In the spring, after the melting of the snow, the vast plain is transformed into a marsh. Then, the shoreline can be reached neither from the land side nor from the sea because of shallow approaches. The shoreline has retreated 40 to 50 kilometers from the settlement of Prorva. The delta of the Ural River has started to disappear as its arms have dried out and the waters of the river now flow only in the delta's main channel.

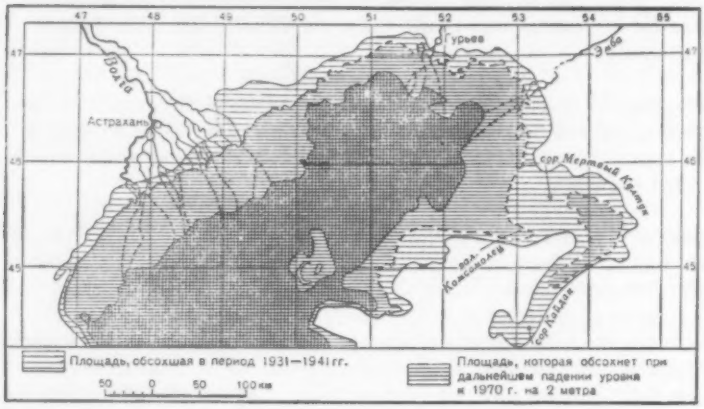

Fig. 1. Changes in contours of the northern Caspian Sea

(Legend:)

Area from which water has retreated in 1931-41

Area from which water would retreat by 1970 if the level drops by 2 more meters

In the last 15 to 20 years the delta of the Volga River has advanced by 25 to 30 kilometers, straightening the shoreline, which has been shortened by 40 kilometers (from 220 to 180). With every drop of 30 cm. in the sea level, the Volga delta has advanced by three to four kilometers. The area of the Astrakhan' nature preserve has been greatly expanded.

With the drop of sea level, the shoreline of the Caspian Sea has been straightened and the area of its islands has been increasing. For example, the Tyulen'i, Chechen', Kulaly and other islands have grown in area by

two or three times. The Cheleken, Dolgiy, Sara and other islands have been connected with the mainland and become peninsulas. Islands of the Volga delta, such as the Tishkovskiye, Belinskiye and others, have also been transformed into peninsulas. Submarine banks -- Chistaya, Ukatnaya, Novinskaya, Dzhambayskaya and others -- have emerged as islands, some already settled by fishermen. The recent drop of the sea level has also laid bare many sand bars, transforming them into islets.

Economic Problems Related to the Fluctuations of the Sea Level. The drop of the Caspian Sea level has had a harmful effect on transportation, the fishing, oil and chemical industries and other segments of the regional economy.

Sea-going and river transport faces many difficulties -- approach channels become shallow, landings and docks are left dry, new shoals and reefs present hazards to navigation. The Volga delta has at the present time only one navigable channel to the sea -- the deep, broad Bakhtemir arm. Many delta arms that were used earlier by the fishing fleets are no longer navigable. Some of the fishery collectives have lost all access by water to the Volga and to the Caspian Sea and lack fresh water even for their domestic needs. Some fishing settlements have been moved to the banks of deeper channels. Heavy capital investments have been required to maintain transport operations. Vessels loaded to capacity can no longer navigate the approaches to ports and landings, channels, ship basins and fairways. In the principal ports of the Caspian Sea -- Baku, Makhachkala, Krasnovodsk and Pahlevi -- and on their seaward approaches, navigation has been maintained only as a result of constant dredging of ship channels. Port Ilyich and the port of Astara in Azerbaydzhan are no longer in operation; the approaches to ports in the northern part of the sea are no longer accessible.

Astrakhan', which has the largest freight turnover among Caspian ports, has been most heavily affected by shallowing. Deep-draft sea-going vessels loaded with goods for Astrakhan' cannot navigate beyond the so-called 12-Foot Roads. Shallow-draft vessels can approach more closely to Astrakhan' through the dredged Volga-Caspian Channel, which is being maintained at high cost. Once a sea channel, it has now become virtually a land canal.

The drop of the Caspian Sea level has also effected the fishing industry. The fish catch has been sharply reduced, dropping from 510,000 to 190,000 tons (not counting sprats) in the period since 1929. The level drop has especially affected the renewal of the fish population because the best hatcheries and feeding grounds in the northern part of the Caspian and in the Volga and Ural deltas have been laid dry. These areas used to yield about 80 per cent of the total Caspian fish catch. The Gasan-Kuli and Kaydak gulfs, once rich in fish, are now dry. Many of the mouths of tributary streams have been left dry, a factor which together with the construction of hydroelectric dams has deprived several species of their natural upstream migration routes for spawning.

The oil industry has also been affected by the level drop. It has disturbed the operations of the large fleet supplying offshore oil wells; it has halted operations at port and landing installations and at the many coastal pumping stations that supply oil wells and refineries with water for industrial and firefighting needs; it has made the drilling and exploitation of new wells more difficult. According to oil-industry calculations, the industry would benefit either from a stabilization of the level or from a rapid drop by more than 5 meters. However, such a drop, which would lay bare large offshore oil fields, is highly unlikely.

The chemical industry of the Kara-Bogaz-Gol, where sodium sulphate is obtained from salt deposits, is also having difficulties as a result of the drop of the sea level.

Agriculture is also suffering, especially in the Volga delta and along the coast of the northern Caspian. Arms and channels have dried up in the Volga delta, hampering irrigation. Many orchards have been abandoned, the area of valuable reed growths has been reduced, the cost of garden irrigation has risen, and in some places livestock farms have experienced a water shortage. It has been necessary to build expensive pasture-watering systems and irrigation works in some areas. A further drop of one meter in the sea level by 1970 would raise agriculture's losses to more than 4 billion rubles.

The drying up of several areas on the northern Caspian has required the resettlement of several populated places. The drop of the sea level has also brought about other serious problems. They include the water supply of Mangyshlak and the transportation of mineral products from Mangyshlak. The level drop has also affected the climate of the northern and northwest shores of the Caspian, increasing its continentality.

The fluctuations in the Caspian Sea level thus present a problem affecting many segments of the economy. The problem can be solved only through the adoption of measures designed to regulate the level of the sea. But before such measures are worked out, we must have a reliable forecast of future level fluctuations.

Forecasting the Caspian Sea Level. As a result of having worked out the long-term forecast of Caspian level fluctuations and having determined the causes of the recent drop, B. A. Apollov established that the basic causes of the drop in the sea level were the general warming of the climate, resulting in a reduction of the stream flow, and, in recent years, increased activity of man, related to the use of the stream flow for purposes of power generation and irrigation.

What is the connection between the Caspian level fluctuations and climatic change, and what are the methods for working out long-range level forecasts?

According to Apollov, climate is affected substantially by fluctuations in solar activity, particularly sunspots. Research has shown that there is a

direct relationship between the number of sunspots and the principal meteorological elements, such as air temperature, atmospheric pressure and precipitation.

A rise in the intensity of anticyclonic circulation over the Volga basin has reduced precipitation and, consequently, the stream flow of the Volga, which makes up 77.8 per cent of the total stream discharge into the Caspian Sea.

Apollov's research in connection with his work on long-range forecasts has shown there has been a gradual rise of temperature in the Caspian basin in the last century, and that the sea level in general has had a tendency to drop. There is no basis for assuming that in the next 10 to 15 years there will be a reversal of this trend, with a sharp cooling of the climate producing an increase in the stream flow of the Volga and other Caspian tributaries. Consequently the level of the sea will continue to drop and the economic losses can be expected to increase.

In addition, man's activity in the Caspian basin has tended to reduce the stream flow. For example, the filling of the Uglich, Ivan'kovo, Rybinsk, Kama, Kuybyshev, Stalingrad, Mingechaur and other reservoirs has been effected and will continue to be at the expense of the stream flow of the Volga and Kura rivers.

Part of the stream flow is lost in filtration, evaporation, water supply for domestic and irrigation needs. Evaporation from reservoir surfaces is increasing. The rivers thus lose a substantial part of their water long before they reach the Caspian Sea. These losses can be expected to increase as hydroelectric construction, irrigation and other water-management measures continue, and the drop of the Caspian Sea level will be affected more heavily by man's activity than by climatic change.

According to the long-range forecasts worked out by B. A. Apollov, N. A. Belinskiy and G. P. Kalinin, the Caspian Sea level is likely to drop by one more meter by 1970, but the possibility of a greater drop is not ruled out. This would bring the sea level to 3.5 meters below the average level of the past hundred years. According to this forecast, a drop of 30 cm. can be attributed to climatic change.

Some geologists try to explain the Caspian level fluctuations in terms of geological factors. But most geologists feel that in view of the lack of uniform direction and the insignificant magnitudes of geological processes in the Caspian, these need not be taken into account in long-range forecasts. P. V. Fedorov, Doctor of Geological-Mineralogical Sciences, who is especially concerned with the geology of the Caspian Sea, has said in this connection: "In working out long-range forecasts of the Caspian Sea level based on an analysis of climatic and hydrometeorological data for the last 50 to 100 years, there is no need to make corrections for crustal movements in the area of the shores and the bottom of the Caspian Sea"

(P. V. Fedorov, "The causes of the fluctuations of the Caspian Sea level in the Quaternary period," Trudy Instituta okeanologii AN SSSR, Vol. XV).

Prospects of Transformation of the Caspian Sea. A further drop of one to two meters in the dea level would increase the problems in the regional economy of the Caspian Sea. To avoid the harmful consequences of the Caspian Sea level fluctuations Soviet scholars have advanced several projects, which among other things seek to solve the problem of regulation of the Caspian Sea level.

One of these projects, proposed by the engineer M. M. Davydov, calls for turning back the course of the Ob' and Yenisey rivers into Central Asia, and from there along the old Uzboy stream channel to the Caspian Sea. But that tremendous project is expensive, requires a great deal of additional research and cannot be realized in the foreseeable future.

Suggestions have been made to connect the Caspian Sea with the Black Sea and to use the difference in level between the two seas to fill the Caspian Sea with Black Sea water. This is not advisable because the saltier waters of the Black Sea would have an adverse effect on the fishery resources of the Caspian Sea. Furthermore, such a project would disturb the hydrological and hydrochemical regime of the Sea of Azov, increasing its salt content and hurting its fisheries. One of the projects that would, among other things, increase the supply of water to the Caspian Sea is the plan worked out by Gidroproyekt (Soviet water-management design organization) calling for diversion of part of the stream flow (about 41 cubic kilometers a year) of the Pechora and Vychegda rivers through the Kama and Volga to the Caspian.

N. S. Khrushchev spoke about the tremendous scope of this plan in his speech to the plenary meeting of the party's Central Committee on January 17, 1961:

"Having carried out this project, we could generate in the hydroelectric stations on the Kama and Volga an additional amount of electric power equivalent to the present output of the Kuybyshev hydroelectric station. You will recall that construction of the Kuybyshev station cost 12 billion rubles. The cost of the structures needed to divert the waters of the Pechora and the Vychegda to a more useful channel is estimated by specialists at 6 to 7 billion rubles. This means that the hydroelectric stations already in operation, for example, the Kuybyshev station, will generate electric power at almost half the previous cost.

"The execution of this project would, in addition, make it possible to regulate the level of the Caspian Sea, which is continuing to drop all this time. We should also bear in mind the fact that the project would open a new economical water route from north to south, for shipping lumber from the northern forests to the south of the country. Solution of this problem would yield other benefits and advantages, for example, in the field of navigation. The southern seas of the Soviet Union would then be linked with the Arctic Sea."

The project calls for construction of dams in the upper reaches of the Pechora River (above the confluence of the Shchugor River) and of the Vychegda (at Ust'-Kuloma), as well as on the Kama River (at the upper end of the Kama Reservoir). This would create three large reservoirs in the upper reaches of the Pechora, Vychegda and Kama rivers, connected with each other by gravity-flow canals. The entire Kama-Pechora-Vychegda reservoir would have an area of 17,000 square kilometers. An average flow of 41 cubic kilometers a year could be tapped from this reservoir (equal in area to Lake Ladoga) and diverted through the Kama and Volga rivers to the Caspian Sea.

This water would increase the electric-power generation at the Kama and Volga stations by 10 to 12 billion kilowatt-hours a year by assuring a fuller load. This would be equivalent to the electric power output of another Kuybyshev hydroelectric station.

Realization of the project would also make it possible to create a deep-water route between the seas of the Arctic Ocean and the Caspian and Black seas. About 800 kilometers of new deep-water routes would be established in the upper reaches of the Pechora, Vychegda and Kama rivers. Pechora coal, lumber from the Pechora and Vychegda basins and other goods could be shipped by this water route to the central and southern regions of the European part of the USSR.

But the diversion, under this project, of 41 cubic kilometers of water a year by 1970 would not compensate the Caspian Sea's water losses, which are expected to have increased even further by that time, and would not restore the former level of the sea. At best the sea level of the Caspian would be stabilized at the 1970 level.

A measure designed to compensate in part for the water losses of the Caspian Sea could be the separation of the Kara-Bogaz-Gol, which now absorbs about 10 cubic kilometers of Caspian water a year. That project could be realized relatively easily and at low cost. The water needed for the sulphate industry could be diverted from the Caspian Sea to the Kara-Bogaz-Gol by a pipeline, which, according to Apollov, could be laid easily across the Karabogaz sandspit, using the nearly 4-meter difference in level between the Caspian Sea and the Kara-Bogaz-Gol. This project would save 6 cubic kilometers of Caspian water a year. It should be borne in mind that a further drop in the Caspian level by one to two meters would result in any case in a separation of the Kara-Bogaz-Gol from the Caspian through the emergence of sand bars at the seaward entrance to the channel linking the two bodies of water, and the Kara-Bogaz-Gol would dry up altogether unless water were transmitted from the Caspian by pipeline.

Having analyzed the situation and come to the conclusion that sufficient water could not be added to the Caspian Sea in the foreseeable future to raise the level of the sea, Apollov proposed the idea of a local regulation of the Caspian Sea level that would solve the problem in an integrated

fashion and at the lowest cost for the benefit of as many economic sectors as possible.

Let us examine in greater detail how the Apollov plan would solve the problem of the northern Caspian, which is the more important part of the sea from an economic point of view and has been affected most heavily by shallowing.

The Apollov plan envisages the construction of an earth dam separating the northern part of the Caspian and transforming it into a North Caspian reservoir whose level would be 2 to 2.5 meters above the rest of the sea (Fig. 2). This would provide an integrated solution for the problems besetting the fisheries, agriculture, the water supply of Mangyshlak, electric power, river, sea-going and railroad transport, and so forth. Realization of the project is not dependent upon the use of materials in short supply. Construction of the dam would require only rock and earth. It would extend from the island Chapur'ya Kosa eastward for 60 kilometers. It would be continued by two parallel dams along the Volga-Caspian channel forming a canal 25 to 30 kilometers long and 600 to 800 meters wide. The dam would then extend eastward for a distance of 255 kilometers. At its eastern end two dams, 30 to 45 kilometers long, would form a second canal providing access to Kulaly Island. A final section of the dam would then extend to Dolgiy Island.

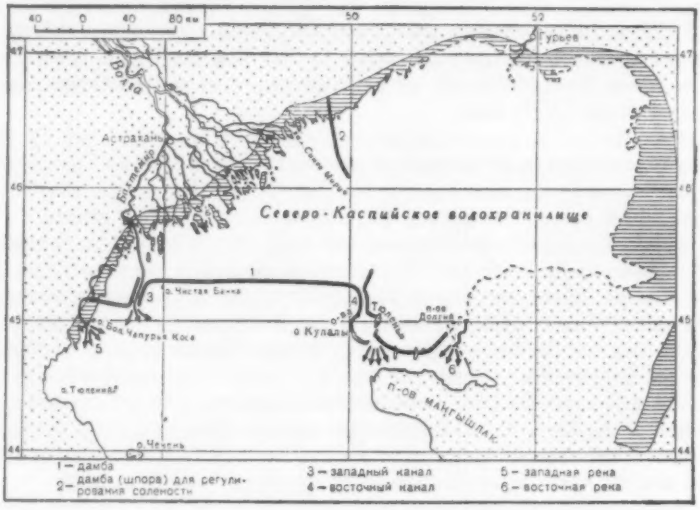

Fig. 2. The Apollov Plan for the northern Caspian Sea

(Legend:)

1 - dam
2 - spur dam to regulate the salinity
3 - western canal
4 - eastern canal
5 - western river
6 - eastern river

For regulation of the salinity in the eastern part of the northern Caspian, the plan provides for construction of a spur extending 40 kilometers southward from the northern shore. The combined length of all dams would be 460 kilometers. The average height of a dam would be 6.5 meters, the width on top 8 meters, and the slope ratio 1:3. The speed of the current in the canals would be an average of one meter per second, which is quite suitable for navigation and the movement of fish.

The eastern part of the Volga delta is now in the process of dying out. The construction of the system of dams and the raising of the water level by 2 meters would result in an increase of the discharge of the Volga into the eastern part of the delta. The Igolkinskiy, Belinskiy and other delta arms would revive as fishery areas.

Construction of the dam would improve the water supply of the entire northern Caspian, the mouths of the Volga and Ural rivers and the eastern and western parts of the delta. This, in turn, would serve to increase the area available for hatcheries and improve the fish-feed supply since nutrients carried by the Volga and Ural rivers would remain within the northern part of the Caspian Sea.

Many important fisheries, now abandoned, would be restored: Zhilaya Kosa, Prorva, Burunchuk and the Lagan (Kaspiyskiy) and Gur'yev fish-processing plants. At the outlets of the two canals, the western with a flow equal to that of the Danube, and the eastern equal to the Dnieper, new deltas would be formed and populated by fish. Fishing conditions would improve since vessels would be able to navigate all arms of the Volga and Ural deltas. The elimination of ice-floe drift will make fishing conditions safer. Fishing settlements could be established on the dam. Fish could be caught in a systematic manner along the fishways in the canals. The location of fish-processing plants on the dam would also improve fish-processing conditions.

Construction of the dam in the northern Caspian would solve the problem of the fresh-water supply for Mangyshlak. Along the eastern canal fresh water would flow to the approaches of the Mangyshlak Peninsula. It would make possible the irrigation and watering of millions of hectares to create conditions for the development of all branches of agriculture, including animal husbandry. This region could then also be easily afforested. A railroad along the dam could provide a short route between the east and west shores of the Caspian and help promote the development of a highly promising mining industry on the Mangyshlak Peninsula. The supply to Mangyshlak of fresh water in unlimited quantity would help promote the rapid opening up and settlement of vast desert areas.

The construction of the dam would also solve the problem of navigation in the mouths of the Volga and the Ural.

The former ports on the eastern shore and on the Mangyshlak Peninsula

would revive. More goods would be shipped by water. Vessels would be able to navigate in the Komsomolets and Kaydak gulfs, which would again come to life. The North Caspian reservoir would be icebound about 20 days later than it is now, but this would not affect the length of the navigation season: the start of navigation depends on the opening of the Volga at Astrakhan', which now takes place 20 days later than the break-up in the northern Caspian; in other words, after construction of the dam, the ice would break up in the mouth of the Volga at the same time as in the North Caspian Reservoir. The southward drift of extensive ice fields from the northern Caspian to the shores of Dagestan and Azerbaydzhan represents a serious threat to offshore oil wells. In 1954 alone drift ice caused hundreds of millions of rubles worth of damage to the oil industry of Azerbaydzhan. The dam would separate the main frozen part of the Caspian Sea and thus eliminate the threat of drift ice to the offshore oil wells of Izberbash and the Apsheron Peninsula. In addition the warm current that travels northward along the east coast of the Caspian Sea would be diverted westward by the dam toward Chechen' Island and help eliminate the formation of ice floes.

Construction of the dam would increase the water area of the northern Caspian, thus restoring the former barrier to the hot "breath" of the desert and improving the climatic conditions of the Caspian lowlands. The northern littoral of the Caspian, thus protected against the effect of the desert and supplied with water over millions of hectares could then become an important agricultural area with a developed animal husbandry.

In connection with the fact that the level of the Caspian Sea south of the dam would drop by one to two meters and an additional littoral zone would be laid dry, the oil industry would gain access to 300 to 400 square kilometers of oil-bearing land areas, thus increasing oil output and reducing production costs and investments compared with offshore wells. The drop of the sea level, if carried out according to plan, could help in the planning of further expansion of offshore wells.

Construction of the dam in the northern Caspian would also help solve other economic problems. The area of the northern Caspian, for example, is poor in energy resources. The difference in level (3 to 4.5 meters) between the northern reservoir and the southern Caspian Sea could be utilized for hydroelectric generation. Such stations could be built on the dam wherever they would be closest to power consumers. A location near consumers, such as fisheries and fish-processing plants, irrigation pumping stations, and electric motive power to draw vessels through the canals, would improve operating conditions of the power stations and reduce capital investments and the cost of electric power.

Construction of the dam would thus help solve major economic problems. At the same time, however, it would speed the drop of the sea level south of the dam by 25 to 30 per cent, producing an additional drop by 1970. This would further aggravate navigation near the shore, in ports, bays, and gulfs, including the ports of Baku, Makhachkala, Krasnovodsk and so forth.

Therefore the Apollov plan also envisages measures to insure local regulation of the water level in those ports by means of dams, locks and the pumping of sea water into the harbor areas. The plan for local regulation of the Caspian Sea level by means of dams would thus meet the interests of many segments of the regional economy. Only under that plan could the level of the northern Caspian be raised by 2 to 2.5 meters within the next two or three years. The cost of construction would be relatively low in view of the shallow depth of the dam-construction area.

The plans of B. A. Apollov and of Gidroproyekt complement each other and solve the Caspian problem in an integrated manner. Work is now under way on the detailed aspects of these plans.

The problem of regulating the level of such a large body of water as the Caspian Sea has never been tackled thus far. There is no doubt that on the basis of present-day achievements of Soviet science and technology Soviet scholars will find the most effective solution for the problem of the level and the transformation of the Caspian Sea.

VERTICAL MOVEMENTS OF THE EARTH CRUST AND THE FLUCTUATIONS IN THE LEVEL OF THE CASPIAN SEA

By V. G. Rikhter

(From Geografiya v shkole, 1961, No. 2, pp. 16-20)

(Abstract: The author acknowledges that climatic factors and man's activity are the principal causes of fluctuations in the level of the Caspian Sea. But he maintains that tectonic processes, such as crustal movements, play a significant part and gives evidence of correlations between geological processes and changes in the sea level.)

The problem of the fluctuations in the level of the Caspian Sea has attracted the attention of scholars in various disciplines over more than 200 years. This is not surprising in view of the fact that the level fluctuations affect many aspects of the regional economy, such as extractive and processing industries, sea-going transport and the construction of ports. The forecasting of future fluctuations in the level of the Caspian Sea is therefore of vital importance for the further development of the economy of the Caspian region.

Travelers of antiquity and the Middle Ages regarded it as incredible that the huge amount of water discharged into the Caspian Sea by the Volga, the Ural, the Kura, the Terek and other rivers should "disappear without a trace." Ignoring the tremendous factor of evaporation in the life of the Caspian Sea, they assumed that the sea has a free connection with the

ocean and discharged its excess water through some kind of subterranean channel. In the absence of reliable information at that time, it was natural to assume that there might be such a channel somewhere in an uninhabited area. That opinion was supported by the legends of the Turkmen and Kazakhs, who reported that they had seen a heavy flow of Caspian Sea water into the gulf Kara-Bogaz-Gol. In fact the very name of the gulf, which means "black chasm" in Turkmen, seemed to support that hypothesis. This belief was so widespread among travelers and seamen that Academician E. Eykhval'd on a voyage along the east coast of the Caspian Sea in 1825 could not persuade the ship's captain to enter into the terrifying gulf.

However, scholars had begun to debate the causes of the fluctuations in the level of the Caspian Sea as early as 100 years before the Eykhval'd voyage. Detailed studies of the Caspian Sea that began under Peter the Great at once led to the problem of changes in level, and the first Caspian explorers, F. I. Soymonov and K. P. Van-Verden, sought to provide an answer to that interesting question. Soymonov is the founder of the climatic theory of sea-level fluctuations. In a report on his Caspian Sea research he wrote: "The Caspian Sea loses in the form of water vapor as much water as the streams discharge into it."

Subsequent observations by Captain Khenvey (1742-44), S. G. Gmelin (1770-72), V. N. Tatishchev (1793), P. S. Pallas (1809) and other explorers supplemented Soymonov's concept of climatic causes for the changes in the level of the Caspian Sea.

But as more data were accumulated many scholars began to realize that the climatic theory alone could not explain the periodic rises and falls in the level of the sea. It was felt that contemporary geological processes along the shores of the Caspian Sea could not but affect the life of that body of water. This idea was formulated most clearly by Eykhval'd, who wrote in his report on Caspian Sea research in 1825-26 about great activity of contemporary geological processes (earthquakes, eruptions of mud volcanoes), the presence of drowned cities, and so forth. He attributed to geological processes the principal role in the fluctuations of the Caspian Sea level. This opinion was supported by Alexander von Humboldt, the great geographer of that period, who visited the Caspian in 1829. Humboldt thought that the fluctuations in the sea level depended on disturbances in the equilibrium between the discharge of water into the sea and evaporation, on the periodic alternation of dry and wet years, on changes in sea currents and on intensive geological processes along the shores and on the bottom of the sea.

Since that time the geological theory has been granted "rights of citizenship" and has been considered on the same merits as the climatic theory.

A study by Academician E. A. Lents, which was published a number of years later, summarized the observations of the preceding explorers. It treated the geological causes of the level fluctuations on the same basis as

the climatic causes. Geological observations were still rather scanty at that time and naturally Lents did not give them much weight in analyzing the fluctuations.

In the middle of the 19th century the studies of two well-known Caspian explorers appeared almost simultaneously in print, propounding diametrically opposed views on the causes of the fluctuations. N. V. Khanykov, hydrographer and climatologist, presented data in favor of the climatic theory, and K. M. Ber, natural scientist, treated the geological on the same level as the climatic causes.

Since each theory has its supporters, the dispute regarding the causes of the Caspian Sea fluctuations has continued to this day.

Supporters of the climatic theory (A. I. Voyeykov, A. F. Vangengeym, Yu. M. Shokal'skiy, N. M. Knipovich. A. A. Kaminskiy, B. D. Zaykov, Ye. V. Oppokov, L. S. Berg, B. A. Apollov, and others) base themselves primarily on the fact that the water balance of the land-locked Caspian Sea is in equilibrium, i.e., the water that the sea receives through various channels (stream discharge, underground discharge, precipitation, and so forth) is evaporated from the surface of the sea. When either the incoming part or the outgoing part of that balance is disturbed, the level of the sea drops or rises. While the amount of water lost in general does not change much over short periods of time, the amount of water received by the sea does undergo sharp fluctuations. The inflow of water is affected by climatic factors and the activity of man, who removes part of the water for purposes of irrigation, filling of reservoirs, and so forth. These measures produce substantial changes in the natural discharge of the streams into the Caspian Sea. Correlations between the amount of water discharged into the Caspian and changes in the sea level show convincingly the important role played by climatic factors and by man's activity in the fluctuations of the Caspian Sea level. The relationship seems so obvious that the partisans of the climatic theory completely ignore the role of geological processes in the basin of the Caspian Sea and their effect on level changes.

Supporters of the geological (tectonic) theory of fluctuations in the level of the Caspian Sea (N. I. Andrusov, A. D. Arkhangel'skiy, I. M. Gubkin, A. V. Voznesenskiy, P. A Pravoslavlev, Ye. V. Milanovskiy, I. P. Gerasimov, V. P. Kolesnikov, N. I. Nikolayev, V. A. Gorin and others) acknowledge that in land-locked basins of the Caspian Sea type the basic causes of fluctuations in level are undoubtedly the above-mentioned climatic factors and man's activity disturbing the natural water balance of the sea. But these scholars maintain that these are not the only causes and that a substantial part is played by vertical movements of the shoreline and the bottom of the sea.

The basin of the Caspian Sea has a complex geological structure. Its northern part is situated on the margin of the pre-Cambrian Russian Platform, where mountain-building processes ended more than 500 million years ago.

Some parts of the platform still experience inherited uplifting and downwarping, which in turn constitute a background for areas with more active vertical movements. Most of the northern Caspian lies in a region of slow and prolonged subsidence -- the Caspian depression with extensive development of salt domes. The magnitude of the subsidence has been determined by repeated geophysical measurements (repeated high-precision leveling) to be of the order of 1 to 3 mm a year although individual salt domes against the general background of subsidence emerge at the rate of 10 mm or more a year.

Farther south is an Upper Paleozoic platform that occupies the western part of the Caspian region and extends eastward through the middle depression of the Caspian Sea. Part of this young platform has been included in the frontal trough of the Caucasus, covering the Terek-Kuma lowland and the western littoral of the Caspian Sea. Within the trough the rate of subsidence reaches 5 or 7 mm a year, while the Upper Paleozoic platform proper undergoes uplifting at the rate of 3 to 4 mm a year.

The rest of the Caspian basin is part of the Alpine geosynclinal zone, the mobile region of major uplifting and downwarping that extends from the Alps to the Pacific Ocean. This region includes the Alps, Carpathians, Crimea, Caucasus, Kopet Dagh, Tien Shan, Pamirs, Hindukush, Himalayas and other mountain systems.

The Alpine geosyncline is characterized by sharply contrasting vertical movements. In a relatively short geological period great mountain systems have been formed here and are still being uplifted at the rate of several centimeters a year. Next to these mountain ranges are large depressions that continue to subside to this day. Some of these depressions are filled with unconsolidated continental deposits and some are occupied by lake basins. One of these lake basins is that of the southern Caspian.

The South Caspian basin, situated between the Caucasus and the Kubadag on the north and the Elburz in Iran on the south is undergoing intensive subsidence. It has been shown by geophysical methods that the rate reaches 16 mm a year in some places. Undoubtedly it is even greater in the central parts of the basin. Detailed surveys of the lake bottom in the southern Caspian have uncovered a complex system of submarine ranges with a relative elevation of 400 meters or more, and evidence of continuing uplifting against the general background of intensive subsidence of the basin as a whole. Lake-bottom core samples have shown evidence of mud volcanism.

Thus there is clear evidence of intensive geological processes both on the shores and on the bottom of the Caspian Sea. According to recent estimates the present-day crustal movements have a sufficiently important effect on changes in the volume of the lake basin and are being wrongly underestimated by partisans of the climatic theory.

One of the characteristic aspects of the present-day crustal movements is their irregularity over time. It has been observed that the tectonic activity

becomes more intense at times only to weaken at other times. And in view of the fact that the movements themselves are inherited, it happens that greater activity of vertical movements results both in uplifting of the Upper Paleozoic platform and in downwarping of the South Caspian basin and the Caucasus frontal trough. This creates considerable changes in the form of the Caspian Sea basin and in its volume.

It has been estimated that the area of the zone of subsidence in the Caspian Sea is 200,000 square kilometers. For an amplitude of one centimeter, the change in the volume of the basin would be of the order of 2 cubic kilometers. In some years, such as 1953, the amplitude of opposite vertical movements has reached 13 cm, which may have changed the volume of the lake basin by 25 to 30 cubic kilometers. In land-locked basins of the Caspian Sea type, an increase in the volume results in the removal of part of the water in circulation to fill the enlarged trough of the basin. During a period of more active vertical movements the water that fills the expanded trough is thus added to the loss side of the water balance. In periods of stabilization, or tectonic quiescence, when the vertical movements may partly change in direction, some of the water may be dislodged from the previously expanded trough and be added to the gain side of the water balance. This is apparently what happened in 1956-58, when the level of the Caspian Sea rose slightly, although there was no substantial increase in the discharge of tributary streams.

The above-mentioned estimates are based on depth-gauge measurements of shore stations. On the basis of known gradients of increase in the rates of vertical movements from the edges to the axial sections of depressions, it would not be wrong to increase the above-cited figure by 2.5 to 3 times, and thus to assume that in tectonically active years as much as 70 to 90 cubic kilometers of water may be added to the loss side of the water balance to compensate for the expanded volume of the basin.

Greater activity of mud volcanoes is also related to vertical tectonic movements along cracks in the earth's crust. Observations of mud volcanism and correlation with the changes of the Caspian Sea level led a Baku geologist, Prof. V. A. Gorin, to establish a relationship between the two phenomena. According to Gorin, mud volcanism in the southern Caspian basin is marked by a rather well expressed periodicity. At times there is a sharp increase in the number of eruptions of mud volcanoes, and at other times there is a noticeable decrease. Periods of increased activity correspond to sharp drops of the sea level between the long-term average. Periods of quiescence, in turn, correspond to rises of the level by tens of centimeters.

The reason for such correspondence must be sought in the large buried blocks of the earth's crust formed along a system of fractures. The fact that mud volcanoes are associated with crustal fractures has been shown by many scholars and is no longer in doubt. A subsidence of the crustal blocks results in a weakening of stresses and in an upward flow of the so-called crater breccia (the product of eruption of a mud volcano). In this case

greater activity of vertical movements also results in an expansion of the volume of the lake basin and part of the water of the annual water balance is lost in filling the expanded basin.

The question of earthquakes as indicators of vertical movements and the effect of earth tremors on changes in the level of the Caspian Sea has not been sufficiently investigated. However, there are indications that a relationship exists. An interesting phenomenon occurred in the spring of 1960. In the evening of April 26 the sea level began to drop rapidly at Baku and fell by more than one meter within two to three hours. This was followed by a sharp rise, a new drop and another rise. That behavior of the sea level was observed simultaneously by all stations in the southern Caspian area. The phenomenon could not be explained by any hydrometeorological observations. However, it turned out that an earthquake had been recorded two days earlier in Iran, and the associated tremors evidently produced brief fluctuations in the bottom of the Caspian Sea and a tsunami-like surface phenomenon.

Thus the importance of present-day tectonic movements with regard to fluctuations in the level of the Caspian Sea is rather clearly evident and can be subjected to analysis. Unfortunately this factor is not sufficiently taken into account in forecasts of future level changes. In conclusion we want to emphasize once again that fluctuations in the level of the Caspian Sea are due largely to changes in the water balance, particularly changes related to climatic factors and to man's activity in the economic sphere. Present-day vertical movements often tend to disturb the observed correlations and usually tend to increase the volume of the Caspian Sea basin, which in turn adds to the loss side of the annual water balance.

THE ARCTIC OCEAN AS A FACTOR IN EASTERN SIBERIA'S CLIMATE

By L. Trube

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(Abstract: The author notes that two Soviet elementary textbooks erroneously list the proximity of the Arctic Ocean as a significant factor in the low winter temperatures of Eastern Siberia. He explains Eastern Siberia's extreme winter climate in terms of three basic factors: northerly location, remoteness from the Atlantic Ocean, the character of the relief.)

Two current Soviet textbooks list the Arctic Ocean among the factors that determine the sharp continentality and very low temperatures of Eastern Siberia's climate.

K. F. Stroyev's textbook for the 7th grade titled Fizicheskaya geografiya SSSR (Physical Geography of the USSR) states on p. 158: "The climate

of Eastern Siberia is extremely continental. This is explained by its remoteness from the Atlantic Ocean, its separation from the Pacific Ocean by a series of mountain ranges, by its high elevation above sea level and by the proximity of the Arctic Ocean."

A teachers' aid by I. S. Matrusov and A. M. Nizova titled Metodika prepodavaniya fizicheskoy geografii SSSR (Methods for Teaching the Physical Geography of the USSR) talks on p. 53 about the strong cooling of Siberia in winter "under the influence of cold air masses of the Arctic Ocean and the Asian continent," and on pp. 239-40 (in a quoted model answer by a student) the book draws attention to the fact that in winter "cold and dry winds from the Arctic Ocean produce no warming effect."

On the basis of the textbook and the teachers' aid, teachers repeat and students learn this deeply ingrained false concept of the effect of the Arctic Ocean on the climate of Eastern Siberia.

Insofar as the textbook is concerned, it should be pointed out that proximity to the Arctic Ocean may explain the length of the winter or the coolness of the summer, but certainly not the continentality of the climate. The ocean tends to reduce the annual range between winter and summer temperatures near the coast compared with more distant inland areas.

As regards the statement in the teachers' aid, the winter situation in Eastern Siberia is precisely the opposite of the one given in the book. Winds do not blow from, but toward the Arctic Ocean since the atmospheric pressure on land, in the area of the East Siberian high, is much greater than over the ocean, where the air temperature is higher. This can be seen easily on maps showing wind directions.

In short the proximity of the Arctic Ocean has no intensifying effect either on the rawness of the winter in Eastern Siberia or even less on its continentality (in fact, the opposite holds true). (According to A. A. Borisov's Klimaty SSSR. Posobiye dlya uchiteley (The Climates of the USSR. A Teachers' Aid), 2d edition, Moscow: Uchpedgiz, 1959, p. 180, "In cyclonic years the low-pressure systems moving through the Far North suck in the air from the area of the Siberian high, thus lowering the pressure in its northern part and raising the winter temperature.") Therefore an effort should be made not to stress the proximity of the Arctic Ocean in order to avoid giving students a false impression about the role of that body of water.

Incidentally, the explanation of the continentality of Eastern Siberia in terms of "its high elevation above sea level" is also incorrect. It is well known that the range between winter and summer temperatures decreases with elevation. The elevation factor can be used only to explain the general rawness of Eastern Siberia's climate.

In order to avoid giving students a false impression of the effect of the

Arctic Ocean on the climate of Eastern Siberia, teachers should make greater use of climate maps showing the distribution of atmospheric pressure and wind directions. It should be noted that the map folder attached to Stroyev's textbook does not contain any maps showing the distribution of pressure systems. There should be such maps and, moreover, it is they, and not the maps of isotherms, that should show wind directions.

How then are we to explain the extreme cooling of Eastern Siberia in winter, which in turn causes the sharp continentality of the climate and, in particular, the formation of the area with the lowest temperatures in the Northern Hemisphere (the Oymyakon-Verkhoyansk area)?

The cause lies in the joint effect of three basic factors: (1) the northern location (most of Eastern Siberia lies north of 60° N, and the Verkhoyansk-Oymyakon area lies within the Arctic Circle); (2) the tremendous size of the territory, as a result of which the inland areas of Eastern Siberia, and especially the Verkhoyansk-Oymyakon area, are far removed from the oceans, especially the Atlantic (this is especially important because an air flow from west to east predominates over the USSR); (3) the character of the relief, with high mountain ranges situated along the margins of Eastern Siberia, especially in the east (which tends to reduce the influence of the Pacific), and the existence of intermontane basins enclosed on all sides by mountain ranges. The latter circumstance is especially significant for the mountain-ringed Oymyakon and Verkhoyansk basins. In these two areas, which resemble tremendous bowls, cold air stagnates and is further cooled in its surface layer as a result of the clear, almost calm weather that prevails under the dominance of the winter high. On some days, especially in complete calm, temperatures drop to almost -70° C.

Only the joint effect of these three basic factors explains the fact that the cold pole of the Northern Hemisphere is located in the northeastern part of Eastern Siberia (in the Oymyakon-Verkhoyansk) area and not somewhere else.

Soviet Beet-Sugar Factories under the Seven-Year Plan (1959-65)

Legend: Factories completed in 1959-60
Factories planned for 1961
Factories planned for 1962-65

Inserts: upper right - Altay Kray and Krasnoyarsk Kray
lower right - Kazakh SSR and Kirgiz SSR

NEWS NOTES

By Theodore Shabad

Some Industrial Problems in the Urals. A more effective effort to coordinate the segments of the Urals industrial economy is urged by S. Pomazanov, a section chief of the Council on the Study of Productive Forces (Ekonomicheskaya Gazeta, May 12, 1961). The region's industrial problems relate primarily to the gap that exists between the high level of industrial development and the inadequate local energy supply, and between certain raw-material-producing and processing industries.

The Urals economic region contains only 0.5 per cent of the potential energy resources of the USSR, but the region's consumption of all types of fuels and energy amounts to 15 per cent of the national total. Because of poor planning, the growth of the fuels and energy industry in the Urals has not kept pace with the growth of energy-oriented industries, such as aluminum, magnesium and organic chemicals. Coal still is the principal industrial fuel resource of the Urals. Coal output in the Urals increased by 5 times from 1940 to 1958 (from 12 million to 61 million tons) while the gross value of industrial output increased by 6.6 times in the same period. The immediate aim is to increase the share of natural gas and residual fuel oil in the Urals fuels balance. Under the seven-year plan (1959-65) natural gas lines are to be laid from the gas fields of Gazli (Uzbek SSR; see Soviet Geography, March 1961, p. 81) and Berezovo (Tyumen' Oblast). The use of residual fuel oil from the Tatar and Bashkir oil fields poses a technological problem because of the high sulphur content of the crude oil. Effective methods remain to be worked out for reducing the sulphur content of the fuel oil for use in thermal power stations.

The use of natural gas and oxygen in Urals blast furnaces is expected to raise furnace productivity by 50 per cent and reduce by one-half the consumption of coke. This is especially important in the case of the Urals, which must bring its coking coal from the distant Kuznetsk and Karaganda basins. It has been estimated that the conversion to natural gas of the power stations and steam plants of Magnitogorsk alone would save the shipment of 3 million tons of coal a year from the Kuznetsk Basin.

It is also planned to increase the capacity of the Urals machine-building industry, which has been lagging behind the rate of growth of the iron and steel industry. A greater part of the Urals output of rolled steel products is to be fabricated within the region. At the present time 65 per cent of the rolled products are shipped out of the Urals to other machine-building centers.

Kara-Tau Phosphate Expansion. One of the key industrial projects of the Seven-Year Plan is the expansion of the phosphate mines at Chulak-Tau in the Kara-Tau mountains of Kazakhstan (Ekonomicheskaya Gazeta, May 11, 1961). The mines, in operation since 1946, are to be expanded with the construction of two surface mines at Aksay and Dzhangas, an underground mine and a beneficiation plant at Chulak-Tau. These mines supply phosphate

rock to superphosphate plants at Dzhambul, Kokand, Samarkand and the recently completed Chardzhou plant (Soviet Geography, January 1961, p. 79). Total Soviet mineral fertilizer production in 1959 amounted to 12.9 million tons. In 1955, out of a total output of 9.6 million tons, 3.8 million was phosphate fertilizer. Apatite concentrate from Kirovsk in the Kola Peninsula supplied the raw material for 83 per cent of the Soviet phosphate fertilizer. The Kara-Tau mines supplied 14 per cent.

Growth of the Sugar Industry. Under the Seven-Year Plan sugar production is supposed to increase from 6 million tons in 1959 to 9.25-10 million tons by 1965. In the first two years (1959-60) of the plan period, 24 sugar factories were completed; 17 more are to be completed in 1961, and 48 additional factories in 1962-65 (see map on P. 68, Pravda, May 17, 1961). In 1959 the Ukraine continued to be the principal beet-sugar producer of the USSR, with 4.1 million tons out of a national total of 6 million. The Central Chernozem Region south of Moscow produced 950,000 tons, and the Northern Caucasus 220,000 tons. Other important beet-sugar producers were Moldavia (157,000), Kirgizia and Kazakhstan (120,000 tons each), Latvia and Lithuania (about 50,000 tons each) and the Altay Kray of Western Siberia (nearly 40,000 tons). The most rapid expansion of the sugar industry is taking place in the Krasnodar Kray of the Northern Caucasus. There the area in sugar beets rose from 58,000 ha. in 1957 to 225,000 in 1960, and the production of refined sugar from 68,000 tons in 1957 to 440,000 in 1960. Ten of the factories completed in 1959-60 were situated in Krasnodar Kray (Ekonomicheskaya Gazeta, May 13, 1961) (see also Soviet Geography, January-February 1960, p. 76).

Additional Data on Soviet Ethnic Groups. The original Soviet 1959 census announcement on ethnic groups (Soviet Geography, March 1960, pp. 71-75) listed no distribution or only partial distribution data for some ethnic groups affected by forcible resettlement during and after World War II. More complete information has become available for the RSFSR (Narodnoye khozyaystvo RSFSR v 1959 godu -- The National Economy of the RSFSR in 1959, Moscow, Gosstatizdat, 1960, pp. 44-46), for the Uzbek SSR (Pravda Vostoka, July 31, 1960) and for the Kirgiz SSR (Sovetskaya Kirgiziya, July 23, 1960). (Additional data for the Tadzhik SSR were printed in Soviet Geography, September 1960, p. 83.)

Of 1,619,000 ethnic Germans in the USSR, 820,000 are in the RSFSR, 40,000 in the Kirgiz SSR, 33,000 in the Tadzhik SSR and 18,000 in the Uzbek SSR. Most of the others, or about 700,000, are believed to be in the Kazakh SSR.

The following distribution data are now available for ethnic groups of the Caucasus:

	USSR Total	RSFSR
Chechen	418,000	261,000
(also 25,000 in Kirgiz SSR, the rest mainly in Kazakh SSR)		
Ingush	106,000	56,000
Karachay	81,000	71,000
Balkars	42,000	35,000

The number of people of the three Baltic groups in the RSFSR is as follows: Lithuanians 109,000 (out of a national total of 2,326,000); Latvians 75,000 (out of 1,400,000), and Estonians 79,000 (out of 969,000).

Tselinograd Oblast Formed. Akmolinsk Oblast of the Kazakh SSR, which was abolished in December 1960 at the time of the formation of the Tselinnyy Kray (Soviet Geography, February 1961, p. 75), has been restored under the name of Tselinograd Oblast, in accordance with the new name of its capital, the former Akmolinsk (Kazakhstanskaya Pravda, April 25, 1961).

Volga-Baltic Waterway. Under the Seven-Year Plan (1959-65) the 150-year-old Mariinsk Waterway is to be reconstructed. The 39 small locks along the 360-km. waterway are to be replaced by 9 larger installations (Ekonomicheskaya Gazeta, November 17, 1960; May 17,1961). The waterway extends from the southern end of Lake Onega near the town of Vytegra, along the Vytegra River, across the Vytegra-Kovzha watershed, and downstream along the Kovzha River, through Beloye Lake, and the Shkesna River to the Rybinsk Reservoir at Cherepovets. The reconstruction project will provide a deep-water waterway between the Volga and the ports of the Baltic and White seas. Reconstruction work will take place in stages. The first stage, involving construction of the Vytegra and Belousovka dams on the Vytegra River, is completed. The Vytegra and Belousovka reservoirs were filled in the spring of 1961. The reconstructed Volga-Baltic Waterway will have a far greater traffic capacity than the antiquated Mariinsk system.

Iova Hydroelectric Station Completed. The last turbine has been installed at the Iova Hydroelectric Station in the border area between the Karelian ASSR and the Kola Peninsula (Murmansk Oblast), raising the station to its full designed capacity of 80,000 kilowatts. The Iova station is part of the 300,000-kw. three-station Kovda hydroelectric system, named for Lake Kovda, on whose tributaries and outlet the stations are situated. The first station, Knyazheguba, situated at the lake's outlet near the town of Zelenoborskiy, was inaugurated in 1955. Iova, the second station, began operations in December 1960 and was raised to full capacity in May 1961. The third station, Kuma, farther upstream, is scheduled to be opened in 1962 (Sovetskaya Rossiya, September 8, 1960; Ekonomicheskaya Gazeta, May 23, 1961).

Some Economic Problems of the Soviet Far East. A.Margolin, a section chief of the Council on the Study of Productive Forces, lists some current economic-geographic problems of the Soviet Far East (Ekonomicheskaya Gazeta, April 7, 1961). The economic development of the region has lagged largely because of its distance from European Russia. Future regional construction projects should be planned from the point of view of the region's proximity to the countries of the Pacific and Southeast Asia. If the regional resources are properly developed, the Soviet Far East could become an important exporter of iron and steel, machines, wood pulp, paper and paperboard, mineral fertilizer, coke, iron-ore concentrate and sawnwood.

The manufacture of cement and other bulk goods should be organized on the basis of local materials in view of the huge distances involved in intraregional shipments. Amur Oblast, which lacks its own cement plant, now receives cement from Primorskiy and Khabarovsk krays over an average length of haul of 1,100 km., 50 per cent higher than the average length of haul of cement on Soviet railroads. Traffic in oil products is marred by irrational cross hauls. Residual fuel oil and kerosene are shipped to Primorskiy Kray from refineries in Siberia and the Urals while the same products are shipped in the opposite direction from the Khabarovsk refinery to Amur Oblast.

The lumber industry of the Far East lacks an adequate processing industry. In 1957-59 about 70 per cent of all wood shipments to other regions of the USSR consisted of roundwood, pitprops and sleepers. Only 18 per cent of these shipments were destined for the wood-deficit regions of Central Asia and Kazakhstan. The rest was shipped to Siberia and the Urals, which have ample timber resources of their own. The region lacks adequate capacities for the manufacture of pulp, paper, paperboard, fiberboard, rosin, turpentine and wood alcohol. Even the current construction of a huge integrated pulp and paper mill at Amursk, southwest of Komsomol'sk, is considered insufficient.

Regional consumption of iron and steel is met only 35 to 40 per cent by the output of the Komsomol'sk steel plant (which has no blast furnace). Future consumption of steel in the Far East is expected to rise to 7-8 million tons. The 300,000-ton Komsomol'sk steel plant could cover only an insignificant part of these needs. The rest would have to be shipped at best over a distance of 4,000 to 5,000 km. from the planned steel plant at Tayshet in Eastern Siberia. It is therefore urged that a large integrated iron and steel plant be built in the Soviet Far East and steps should be taken to explore the resource basis for such a plant.

An agricultural expansion program based on state farms is urged to assure an adequate local supply of wheat, vegetables, potatoes, corn and especially soybeans. Construction of the first of a series of planned hydroelectric stations in the Amur basin is urged on the Zeya River (an Amur tributary) to protect the populous Zeya-Bureya farm lands against annual flooding.

A manpower shortage continues to be a major handicap in regional development. Experience shows that higher wages and other monetary inducements are insufficient to attract labor to the Far East. Adequate housing and other living conditions must be created in the Far East before the manpower problem can be solved.

Kazakhstan Aluminum Project Advances. Stripping of the overburden has begun on the site of the Arkalyk bauxite deposit in Kustanay Oblast (Izvestiya, April 28, 1961). The first bauxite production is planned for 1963. The Arkalyk deposit, which is linked by a spur to the South Siberian Railroad, is expected to supply an integrated alumina-aluminum plant under construction at Pavlodar. A pilot plant for the conversion of the high-silica Arkalyk bauxite into alumina is under construction at Pavlodar. Completion of the pilot plant has been delayed because of indecision concerning the alumina process to be used. The latest report is that the combination Bayer-sinter process will be used (Kazakhstanskaya Pravda, May 17, 1961).

Stavropol' Synthetic Rubber Plant Opens. A new synthetic-rubber polymerization plant has been completed at Stavropol'in Kuybyshev Oblast on the Volga River (Pravda, May 16, 1961). The plant will produce butediene-methylstyrene rubber, which is the Soviet Union's general-purpose synthetic rubber. Raw materials are supplied to the Stavropol' plant by the oil refinery (by-product butane) and the synthetic-alcohol plant (methylstyrene) at near-by Novokuybyshevsk, a new industrial city southwest of Kuybyshev. The Stavropol' plant, which is situated near the Kuybyshev Hydroelectric Station on the Volga, uses the same synthetic-rubber technology as the Sterlitamak plant of Bashkiria, opened in 1960 (see Soviet Geography, June 1960, p. 76; June 1961, p.54).

CURRENT LITERATURE

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